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A LABOUR MARKET ASSESSMENT OF THE ADVANCED TECHNOLOGIES IN ALBERTA

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Prepared for:
Alberta Career Development and Employment

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Calgary, Alberta

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EXECUTIVE SUMMARY

1.0 OBJECTIVES AND SCOPE OF THE STUDY

Science and new technology development are receiving increasing attention worldwide. Governments have realized that in order to remain competitive in the international market, strong technical and scientific capability must be fostered. The Canadian and provincial governments, the private sector, and research institutions recognize that technological capabilities must be developed and implemented in order to maintain and improve economic competitiveness and productivity. As outlined in a background paper on the Canadian National Science and Technology policy

> It is no longer possible to rely mainly on wealth generated from natural resources and the traditional manufacturing and service sectors. Rather, it is necessary to move to an economy based on the more intensive utilization of technologies to enhance the competitiveness of these sectors, as well as to create new knowledge-based industries.

A key for developing these new knowledge-based industries or more intensive use of the advanced technologies in Alberta will be the human resource capabilities currently available or that can be developed in the province.

As such Alberta Career Development and Employment commissioned a study, the purposes of which were to prepare a profile of the advanced technology capabilities in Alberta's labour force, identify the anticipated growth areas in the next three years, determine the skills not available in Alberta to meet current and future growth areas, and define industry-based training requirements.

The definitions of what constitutes the advanced technology fields vary but for the purposes of this study the term "advanced technology" refers to those technology areas that are supported by the Alberta Government in its economic development strategy. These areas include:

a) telecommunications;
b) medical products;
c) biotechnology;
d) electronics/microelectronics;
e) advanced materials including plastics;
f) computers and software;
g) cold region engineering;
h) advanced design, processing and manufacturing; and
i) energy.

A second purpose of the study was to develop the text for an international marketing document of Alberta's human resource capabilities in the advanced technologies.

During the course of the study, it was decided to limit the scope of the study in several ways. First, the Electronic Industry Association of Alberta had just completed a comprehensive survey of its members. Relevant information was drawn from this survey rather than re-interviewing industry members. Second, it was also decided to focus on product-oriented firms rather than the service firms and the non-energy sectors because there was considerable information available on the human resource requirements in the energy field.

2.0 METHODOLOGY

Personal interviews were conducted with the owners or managers of seventy-three advanced technology firms in Alberta. The interviewers covered the firm's products; research directions; its stage of development; past, current and expected future employment levels; the academic qualifications and experience of its staff; why it located in Alberta and its recruiting policy. Open-ended questions were also asked concerning growth areas in their industry, critical human resource requirements, training and upgrading needs, improvements to educational programs and the value of cooperative education programs.

This interview guide was developed after extensive discussions with government, education and industry representatives, a review of relevant prior research and analysis of existing statistical information. The population of firms to be surveyed was drawn during the fall of 1987 from Alberta Technology, Research and Telecommunications' CANTECH database of advanced technology firms.

The issues and possible recommendations identified in this study as well as a draft of the marketing document were discussed in focus groups composed of industry, government and educational institutions involved in the advanced technologies.

3.0 OVERVIEW OF THE SURVEY RESULTS

Approximately half of the firms interviewed were at the inception, prototype testing or growth stages of development with nearly one-third in the growth stage. This indicates a relatively young group of firms involved more in development than production, implying a greater demand for researchers and relatively less demand for the lower-skilled production worker.

Most of the firms were small; more than 75% had less than $5 million in sales revenue while 15% had annual revenue of less than $100,000 - results that are not surprising given the stage of development of many of the firms.

As with most small firms, the founder's familiarity of the area was by far the key factor in siting the firm in Alberta although proximity to customer markets (the oil industry) and quality of life factors for employees were also important.

The seventy-three firms interviewed had 2954 employees, an average of 40.5 employees per firm although the median size was only twelve employees. They had grown on average by 10% over the last two years but expected to grow by 43% over the next two. Significantly no firms foresaw a decrease in sales revenues over either the next two or four years.

Eleven percent of employees were in the manager/entrepreneur classification and sixty-six percent of these people had a diploma or degree. Scientists, engineers and researchers comprised twelve percent of employment with 97% having a diploma or degree.

While most firms did much of their recruiting in Alberta, almost half recruited from a broader geographic area. Not surprisingly, most of the out-of-province hiring was for managers and entrepreneurs or scientists, engineers and researchers.

Finally 37% of responding firms had previously participated in co-operative education programs while 75% were interested in participating in such a program.

4.0 RECOMMENDATIONS

Worldwide technology changes are being transmitted to the regional labour markets creating strong demand for new skills and making other skills obsolete. This constant adaptation means life-long learning must become an important part of our culture. The following recommendations to help manage that adaptation process

are presented by the consultant to Alberta Career Development and Employment and the other stakeholders in the advanced technologies for their consideration.

4.1 Cooperative Programs

The transformation to knowledge-based technologies is increasing the need for close cooperation between industry and our educational system. Human resource policy studies and surveys of industry requirements all stress the importance of improving the student's preparation for entering the workforce. Academic institutions have been moving toward more cooperative programs despite the fact that they are more costly to deliver. The programs also involve costs for the participating firms but most firms strongly believe that the benefits of better prepared graduates clearly outweigh the costs.

<u>We therefore recommend the Alberta educational institutions, and the universities in particular, make a concerted effort to develop more cooperative programs.</u>

<u>We also recommend that the provincial government take a strong policy stand in support of cooperative education programs and provide additional funding specifically targetted for these programs.</u>

4.2 Apprenticeship-Like Programs

An alternative to cooperative education programs is an apprenticeship-like program for advanced technology areas such as microelectronics, biotechnology computer-aided design (CAD) and computer software design. Alberta has an excellent apprenticeship program and the learning component without the legislative dimension could be adapted to these new areas. The new programs would involve a defined series of learning experiences together with clearly defined evaluation criteria and procedures. The main advantages of apprenticeship-like programs are that they are initiated and controlled by industry, that they can be adapted to any size and that procedures and control systems are already in place.

<u>We therefore recommend that Alberta Career Development and Employment encourage the development of apprenticeship-like programs in advanced technology areas.</u>

4.3 Training and Management Institute for Advanced Technology

Small and medium sized research companies tend to be technology oriented rather than market driven. The entrepreneurs often face a major dilemma in determining how to successfully bring their products to the market. Thus a key concern of many of the interviewees was the development or upgrading of the management and marketing expertise in the company. Also, because they are often small with low profit margins, they cannot afford the monetary and time-lost costs of training. Moreover, their costs are such that they cannot spend the time to acquire an awareness of the government support programs available.

A Training and Management Institute for Advanced Technology could provide several services from serving as a focal point for increasing the awareness of the need for life-long learning and delivering training needs assessments and advice on training strategies to facilitating management and marketing training for entrepreneurs. The Institute could also maintain an inventory of training available in Alberta and conduct research on the changing human resource requirements in the advanced technologies. Some rationalization of existing services might be required if such an Institute were created but this should be relatively straightforward.

We therefore recommend that Alberta Career Development and Employment give strong consideration to the establishment of a Training and Management Institute for Advanced Technology.

4.4 Training Guarantees

Another reason for many managers of small firms not encouraging training for their employees is the potential loss of the employee after their skills have been upgraded through company sponsored training. This training is costly both in terms of out-of-pocket costs and time lost on the production line. If the employee then decides to quit, the firm must incur retraining costs.

Alberta Career Development and Employment could remove some of this down-side risk by providing training guarantees for compensation of out-of-pocket costs if an employee does leave. Such a program would be less expensive for the government than a subsidy program which covers all firms, not just those losing staff.

Thus we recommend that Alberta Career Development and Employment investigate the viability and likely effectiveness of a training guarantee program to stimulate more human resource upgrading by companies.

4.5 Technical Research Assistance Program

The Ontario Government will subsidize the hiring of new technicians, engineers and scientists for Ontario companies with sales revenue of less than $100 million. With the proper guarantees to ensure incremental hiring and appropriate job responsibilities, such a program might be very valuable for securing additional technical competence.

<u>We believe that this idea has considerable merit as a mechanism to improve Alberta's technological base in the advanced technologies and recommend that Alberta Career Development and Employment investigate the potential of such a program.</u>

4.6 Increased Awareness of Industry in the Public School System

Several interviewees and previous policy papers have stressed the importance of improving students' awareness earlier in the education process of future industry opportunities and the skills and attitudes necessary to realize these opportunities. This is to ensure that the student is acquiring the necessary prerequisites for their later career paths. Options include an Industry Expo for junior high schoolers, plant visits, and talks by entrepreneurs or managers.

<u>We recommend that the Research Development Authorities in Edmonton and Calgary or a similar municipal organization take the initiative for an annual Industry Expo or some other awareness progam targetted to the high school students in their city and that Alberta Career Development and Employment consider financially underwriting some of the costs of the program.</u>

4.7 Industry Purchased Training

One strategy that has been successful in other jurisdictions is for a firm or industry to financially underwrite part of the cost of a particular academic program when a large proportion of the graduates are hired by the firm or industry. Alternatively the academic institutions may develop company-specific training programs on request. Most firms don't recognize this willingness on the part of the academic institutions, particularly the technical institutes and community colleges.

<u>Corporate human resource development managers, particularly in the medium and larger sized firms, should explore with their local post secondary institutions, the possibility of courses designed specifically to fulfill their requirements.</u>

4.8 Transition Training

A major failing for many entrants in the job market is a lack of appreciation of what is required to obtain a job and then do it effectively. University students in particular have an imbalance between their technical skills and their understanding of business processes.

<u>We suggest that Alberta Career Development and Employment conduct a study on the availability of school-to-work transition type courses in terms of both content and location and determine whether there is an unmet need for such a program. The Department may also train the trainers of such courses.</u>

4.9 Strategic Procurement

The Alberta government is missing a significant opportunity to develop Alberta capabilities in key industries such as computer software design by not requiring work they contract for be done by Alberta-based firms. Most of the advanced technologies in Alberta lack the critical mass or minimum market size to develop an effective industry. However as the Quebec government and Hydro Quebec showed when they used their purchasing power in the 1970's to help create three major engineering firms that now compete worldwide, targetting procurement strategies creates a significant opportunity to develop a local capacity to compete in the world markets. However, such a strategic procurement policy would require a change in current practice and may be inconsistent with the recently signed Free Trade Agreement.

<u>Nevertheless, strategic procurement represents a powerful policy to improve the human resource capabilities in the advanced technology fields in the province and we recommend that Alberta Career Development and Employment strongly consider taking a lead role in promoting its adoption as provincial government policy.</u>

4.10 Future Updating of the Advanced Technology Labour Force Assessment

As Alberta's advanced technologies grow, it will become increasingly important to remain appraised of their human resource requirements. If the Training and Management Institute for Advanced Technology is established, it would be in the best position to acquire and maintain this information as part of its research mandate. Updating the information would likely be most effective if it were done on a technology area by area basis. This would allow different areas to be updated each year and for the information to be gathered for both product and service oriented firms.

If the Institute is not a viable idea, Alberta Career Development and Employment should work closely with Alberta Technology Research and Telecommunications to modify the CANTECH database to include the requirements of Alberta Career Development and Employment.

We therefore recommend that the updating of the labour force assessment of the advanced technologies be part of the mandate for the Training and Management Institute for Advanced Technology. We further recommend the information be updated on an area by area basis over a three or four year cycle and that service-oriented firms be included in the assessment.

5.0 CONCLUSIONS

The world economy is becoming increasingly dependent on knowledge-based goods and services - more specialized products whose value resides mainly in the skill and ingenuity of the people who develop and manufacture them. Developing an advanced technology capability in Alberta has been a main focus of government policy in recent years and the primary purpose of this study was to provide information on what progress has been made in terms of human resource capabilities, its anticipated future needs and on Alberta's ability to meet these needs.

Our study has shown that while no general labour shortage exists, specialized skills, particularly in biotechnology and telecommunications, are not available here in Alberta. As many firms are in the inception, prototype testing or early growth phases of development, there has not been an overly large labour demand for the advanced technologies to date. However, this could change rapidly if a few firms achieved a threshold level of international sales and begin to grow rapidly. If such a situation does develop, the greatest demand will be for production workers and technicians. Demand for manager/entrepreneurs and scientists/engineers/researchers is expected to grow steadily in the next four years.

Several programs currently in place respond to some of the training needs of the advanced technologies but more can be done. Some of the initiatives recommended such as increased involvement of industry in the educational process through more cooperative programs and/or apprenticeship-like programs are supported by several industry sectors and would enhance the human resource capabilities of all firms including those in the advanced technologies. Others such as the Training and

Management Institute and the Technical Research Assistance Program can be targetted specifically to the advanced technology fields. Finally a strategic procurement policy designed to strengthen local firms to the point where they can compete in the world markets would strongly stimulate the development of a world class human resource capability to support the growth of advanced technology firms in Alberta.

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ACKNOWLEDGEMENTS

The DPA Group Inc. would like to thank those industry leaders and government and educational representatives who participated in the survey and the focus groups. Their willingness to give generously of their time is most warmly appreciated.

We would also like to acknowledge the fine contributions of Dr. Marilyn Mohen, Mana Research Ltd. who has a superb understanding of government statistics and works with such enthusiasm and commitment, and Richard Roberts, and his staff at PRAXIS for their creativity in developing the marketing document associated with this study.

LIST OF ABBREVIATIONS

ACDE	Alberta Career Development and Employment
ATRT	Alberta Technology, Research and Telecommunications
ARC	Alberta Research Council
CAD	Computer-Assisted Design
C-FER	Centre for Frontier Engineering Research
EIAA	Electronic Industry Association of Alberta
NAIT	Northern Alberta Institute of Technology
SAIT	Southern Alberta Institute of Technology
SIC	Standard Industrial Classification
U of A	University of Alberta
U of C	University of Calgary
VENCAP	Vencap Equities Alberta Ltd.

1.0 INTRODUCTION

1.1 The Impact of New Technologies

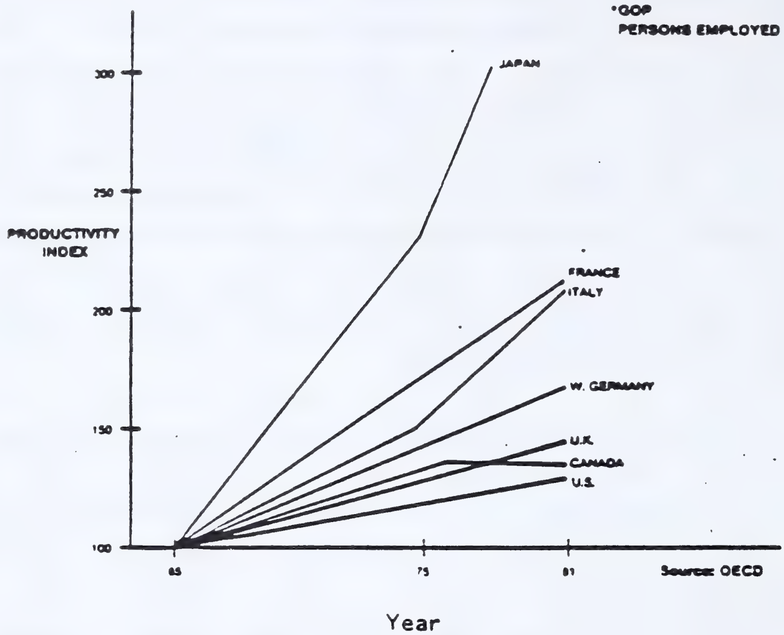
Canada has entered a new era. Wealth and job creation depend on the growth of knowledge-intensive industries and on the application of technology to keep established industries competitive. The explosion of innovation activity is changing technical competence around the world and it is changing the basis of national and corporate competitive strength in the international markets. More importantly, technological advances are determining how jobs will be created and in what countries. National and provincial economies that lag behind will have increasing difficulty creating income and employment opportunities.

Canada has not been adapting as rapidly as other countries to the use of new technologies. This is reflected in the relatively modest improvement in labour productivity in manufacturing from 1965 to 1981 (Exhibit 1.1) (The productivity index, measures the increase in value of output in constant dollars relative to the increase in the labour force over a given period of time and technological change is the primary underlying factor for changes of this type). This slow adaptation is reducing our ability to compete and eroding our export potential and thus costing Canadians jobs.

The problem can be clearly seen by examining the sources of economic growth and job creation, most of which at the national level have been attributable to the performance of the service industries (Exhibit 1.2). The resource sectors which account for approximately 40% of Canada's GNP, have made virtually no recent contribution to overall economic growth.

EXHIBIT 1.1

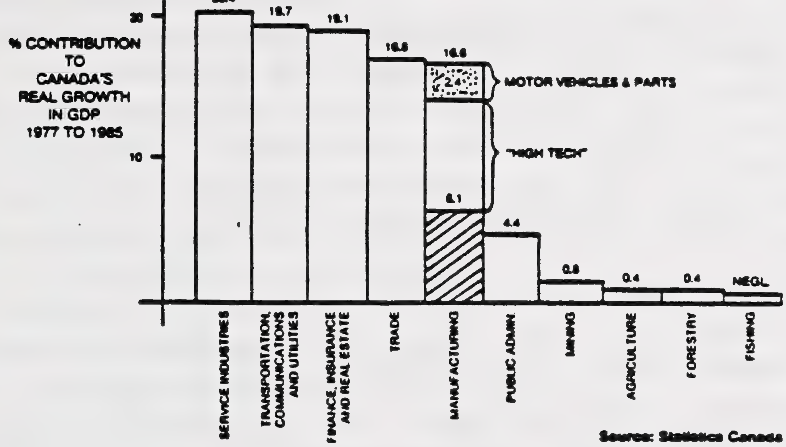
LABOUR PRODUCTIVITY IN MANUFACTURING
1965–1981



While the resource and mass manufacturing industries will continue to make large absolute contributions to the Canadian economy, they are unlikely to contribute much to Canadian economic growth or to create additional employment in the future. This poses a major dilemma for policy makers. There is limited growth and employment potential in over 40% of the economy. There is also a limit to the number of service sector jobs that a slowly growing economy can sustain; yet the advanced technology segment on which our future economic prosperity depends is not filling the void.

EXHIBIT 1.2

SOURCE OF CANADIAN ECONOMIC GROWTH 1977–1985



Source: Statistics Canada

1.2 Alberta's Response

The Alberta government has recognized this imperative to broaden and deepen this segment of the economy. A cornerstone of its economic development policy has been to support the emerging knowledge-based or technology-generating areas. While technological innovations can be applied in any industry, the following are usually considered to be the technology-generating or "advanced technology" fields in Alberta:

telecommunications;
medical products;
biotechnology;
electronics/microelectronics;
computers and software;
advanced materials (including plastics);
cold region engineering;
advanced design, processing and manufacturing; and
energy.

Specific examples of the Alberta Government's support in the above-mentioned areas include: establishing the Alberta Heritage Foundation for Medical Research; founding and jointly funding the Alberta Telecommunications Research Centre and the Alberta Microelectronics Centre; establishing the Electronics Test Centre through the Alberta Research Council and providing financial support to establish the Alberta Laser Institute. Alberta spent $222.2 million in 1984, representing an expenditure on research and development that was three times more than any other province.

Post-secondary institutions have also actively supported these initiatives with, for example, the establishment of technology-transfer offices, encouragement of spinoff companies to commercialize promising research, the development of custom-made courses for industry and the acquisition of a supercomputer.

Other levels of government and organizations are also involved in developing a technology industry in Alberta. In Edmonton for example, the Advanced Technology Project - a joint venture of the Edmonton Council for Advanced Technology and the Edmonton Economic Development Authority - has been established to develop a plan to create a high technology centre in Edmonton. In addition, other organizations, such as the research and development park authorities in Edmonton and Calgary, are actively involved in developing the advanced technologies.

1.3 The Human Factor

These are extremely important initiatives but perhaps the most important resource for any knowledge-based industry is its people. Without a skilled workforce, technology cannot be productive. Alberta has many of the critical human resource requirements for strong advanced technologies including:

- Alberta has the highest proportion of working age people in Canada;

- The province has had consistently higher participation rates for both men and women than elsewhere in Canada and internationally;

- Calgary and Edmonton rank first and third among the major Canadian centres for employment in the natural science, engineering and mathematics;

- Alberta has one of the largest pools of scientific experience per capita in the world;

- Alberta has the highest proportion of people with university degrees among the Canadian provinces;

- With only 10% of Canada's population, Alberta produces nearly one-quarter of the nation's apprentices;

- Calgary and Edmonton have the highest participation rates in adult education and Alberta is the leading province in terms of job-related adult education.

However, the Alberta population is aging as a result of a continual decline in the birth rate, increased migration from Alberta and lower numbers of interprovincial migrants entering Alberta. Moreover, while Calgary and Edmonton rank highly in terms of science, engineering and mathematics trained people in Canada with 44 and 28 such people per 1000 in the work force respectively, we are now competing in a world economy and intra-Canada achievements pale against what is being achieved elsewhere (see Exhibit 1.3).

EXHIBIT 1.3

SCIENTISTS AND ENGINEERS PER 10,000 PERSONS IN THE LABOUR FORCE - 1981

Japan	69
United States	62
Germany	47
France	37
Netherlands	36
Sweden	35
Canada	25
	Source: OECD

(Note the subtle change in definition from science, engineering and mathematics trained people to scientists and engineers.)

One estimate of the size of Alberta's advanced technology segment has approximately 750 firms with 25,000 employees while a second study places total employment at 90,000. A key reason for this discrepancy is the difficulty in identifying advanced technology firms. They occur in virtually every Standard Industrial Classification (SIC) and different studies use different criteria. However, whatever the definition used, little is known about the makeup of the firms' human resources. Nowhere does there exist good baseline data on the current human resource capabilities or expected future requirements.

1.4 The Purpose of This Report

Alberta Career Development and Employment (ACDE) commissioned the DPA Group Inc. to undertake this study to identify current workforce supply and the skills necessary to meet current and future needs of advanced technology firms in Alberta. Specifically, the Terms of Reference identified the purposes of the study as:

a) prepare a labour market profile for Alberta, Edmonton, and Calgary using characteristics that are considered by advanced technology firms when evaluating the siting of an operation in Alberta;

b) document the programs available in Alberta's post-secondary institutions that supply the skills relevant to the advanced technology firms in Alberta;

c) determine the types of workforce skills that were recruited from outside Alberta by firms currently in Alberta and the reasons why out-of-province recruitment occurred;

d) determine the advanced technology growth areas in the next three years for firms currently in Alberta;

e) determine the skills not available in Alberta to meet current and future growth areas;

f) propose a cost-efficient method of updating the information outlined (a to f), and an appropriate interval for updating the information.

There were to be three reports generated as a result of this project (see Appendix A for the Terms of Reference):

a) A policy report that documented future growth areas, the workforce skills required but not available in Alberta and industry-based training requirements to meet this growth;

b) An inventory of post-secondary programs available in Alberta's educational institutions that can supply the advanced technologies in Alberta; and

c) A report that could be used as the text for a promotional document presenting Alberta's human resource capabilities in advanced technology.

During the course of the study, the inventory of relevant educational programs was reduced in scope from a separate report to be included as a part of the first report. The initial requirements for a complete inventory were found to be far too extensive to be able to completed as a part of this study.

1.5 The Structure of the Report

In the next chapter, we briefly present the methodology used in this study followed by a chapter providing a brief overview of previous research relevant to the purposes of this study. The general characteristics of the labour market are then presented in Chapter 4. Chapter 5 provides an overview of the infrastructure for advanced technology firms, including research institutes, educational institutions and financial incentives. The results of our survey are presented in Chapter 6 together with results of a similar survey undertaken by the Electronic Industry Association of Alberta. The study concludes with a discussion of the critical issues identified during the course of the study and presents a series of suggestions and recommendations for Alberta Career Development and Employment and other stakeholders to consider. This final chapter also includes recommendations on a cost-efficient method of updating the information defined in Section 1.4 and an appropriate interval for doing the updating.

2.0 METHODOLOGY

The development of this paper evolved in three distinct phases: scoping, interviewing, and analysis and report writing. The entire study involved continual and productive interaction between the client and consultant. Preparation of the marketing document followed a parallel development.

2.1 Scoping

The scoping phase carried out during the fall of 1987 included a review of existing research; an analysis of existing Statistics Canada, Alberta Bureau of Statistics and Alberta Labour data sources; and open-ended interviews with senior government officials and key industry and educational representatives. The interviews and background research helped define information required as an output of the study and the gaps in currently available information.

The outcome of this process was an interview guide designed to overcome the critical information gaps. The guide was tested, improved and a set of interviewer instructions were prepared. Copies of both the guide and the interviewer instructions are included as Appendix B.

At the same time, the population of firms to be sampled was being defined. It was decided to use the CANTECH database developed by W.G. Hutchinson and Company Ltd. for Alberta Technology, Research and Telecommunications (ATRT). This database on all technology-oriented firms in Alberta is the most current and comprehensive listing available. Characteristics of a firm that are included on the database are:

- location
- age
- products
- markets
- R&D staff and budgets
- range of sales revenues
- range of the number of employees
- key executives and their responsibilities

The CANTECH industry classifications were cross-referenced to the advanced technology fields defined in the Terms of Reference. Also because the purpose of this study was to learn more about the knowledge-generating firms, it was decided to focus on product-oriented firms as opposed to service companies.

This produced a sample size of 312 unduplicated sampling candidates. The breakdown by industry and CANTECH classification is given in Exhibit 2.1. It should be noted that there is no direct correspondence between the study categories and the CANTECH classifications. For example, there is no single classification for electronics; however the Advanced Manufacturing and Electronics fields together generally correspond with the Automation, Subassemblies and TAM classifications. It also proved extremely difficult to identify firms specializing in cold-region engineering because there was no separate code provided for this category within the database.

In 1987, the Electronic Industry Association of Alberta (EIAA) completed a comprehensive survey of its members. Most of the questions to be asked in this survey were included as a subset of the EIAA questionnaire. Moreover, the EIAA had obtained an excellent response rate (101 out of 120 members). It was therefore decided to purchase the applicable results from the EIAA

EXHIBIT 2.1

SAMPLING STATISTICS

	Population	Sample Drawn	Interviews Completed
Advanced Materials			4
Chemicals	5	5	
Materials	5	5	
Advanced Manufacturing			16
Automation	14	10	
Defense	1	1	
Food Processing Equipment	1	1	
Manufacturing Equipment	1	1	
Transportation	5	5	
Biotechnology	9	9	9
Computers			21
Hardware	13	12	
Software	138	35	
Electronics			5
SubAssembly	25	10	
TAM	36	15	
Energy and Environment	30	15	5
Medical	9	8	3
Photonics	8	6	4
Telecommunications	12	8	6
	312	146	73

rather than duplicate their efforts. The fifty-one firms identified in the CANTECH population which had completed the EIAA questionnaire were thus deleted from the list of potential interviewees, leaving a total of 259 firms. This population was then stratified by industry and a sample of 146 firms drawn. A bias was built

into the sampling procedure to ensure that advanced technology fields with relatively few firms were represented. Care was taken to ensure the sample was representative in terms of both geographical location and size. Of the 146 interview candidates, 58 were located in Edmonton, 80 in Calgary and 8 elsewhere in Alberta.

A careful review was also made of existing data on the educational programs at the universities, technical institutes, community colleges and private schools whose graduates might enter the advanced technologies. However, as technological innovation may occur in any industry, and there is not a specific advanced technology SIC code or unique teaching curriculum, the number of possible programs was overwhelming. As Alberta Career Development and Employment had recently completed a major post graduate student employment follow-up study for the technical institutes and community colleges. It was decided that general information from this recent study and comparable statistics at the university level would be used for this advanced technology study.

2.2 Interviews

Personal interviews were arranged in Calgary and Edmonton while the out-of-town interviews were conducted by telephone after the respondent had been mailed a copy of the interview guide. The results of our efforts to contact the people in each geographic sub-sample are shown in Exhibit 2.2.

2.3 Analysis and Report Writing

As the first step in the third phase, the completed interviews were carefully analysed and summaries of the quantitative and qualitative answers prepared.

EXHIBIT 2.2

RESULTS OF ATTEMPTS TO INTERVIEW

	Calgary	Edmonton	Out-of-Town
Completed	37	31	5
Agent only; no manufacturing	2	-	-
No current telephone in service or wrong number	1	3	2
No longer in business in Alberta	2	4	-
Refused	7	3	-
Not available during survey period	11	6	-
Part of another surveyed firm	-	1	-
Unsuccessful attempts to contact	14	5	1
Contact not attempted due to time constraints	6	5	-
TOTAL	80	58	8

A stategy paper of human issues in Alberta's advanced technologies was prepared as input into a series of focus groups. It was originally intended that a focus group be held in both Edmonton and Calgary but timing constraints restricted the possible turnout in Edmonton and thus only one focus group was held.

The responses, reactions and suggestions provided in this meeting were then incorporated into this report.

2.4 The Marketing Document

A parallel process was conducted to develop the marketing document. As information relevant to the marketing document was developed through statistical analysis, document review and interviews, this information was supplied to the group developing this document. A series of interviews with industry, government and education people that may have a vested interest in the marketing document were also conducted.

Several drafts of the document were discussed with the client before it was given to the Communications Branch within Alberta Career Development and Employment for review and revision.

This document was also presented to a focus group for review and discussion. This meeting was held in Edmonton; a similar meeting had to be cancelled for Calgary due to prior commitments of the attendees.

3.0 REVIEW OF RELEVANT PRIOR RESEARCH

There has been a growing realization of the importance of innovation and technology on the future directions of our economy. David Birch and other authors have shown conclusively that emerging advanced technology firms contribute a substantial proportion of the labour force growth in North America. There was also the realization that regional stagnation was a distinct possibility if adaptation to the new technologies did not occur. This led to two major research thrusts - a political initiative by municipal and regional governments everywhere to try to attract "high tech" firms and an academic thrust to determine what were the key determinants of a firm's relocation decision. Three of these latter research efforts are of particular relevance to this report.

Typical of the locational research was the work of Grubb and Ellis who surveyed tenants of industrial parks to determine future real estate requirements of biotechnology firms. Large companies were found to be interested in proximity to research institutes, qualified labour, good transportation access, favourable business climate and well planned low cost development infrastrusture. Small companies on the other hand, were more influenced by local familiarity of founders, venture capital, expansion opportunity, proximity to universities, good transportation access, skilled labour, as well as a favourable community and business climate. Quality of life was the fourth most important criteria for large companies, but was not a consideration for small companies. Quality of life factors included affordable housing, low real estate taxes, and a wide range of cultural, recreational and educational opportunities.

The importance of skilled labour in the decision process for both groups is a typical result in the academic research. The key contribution of Grubb and Ellis was the recognition of the different

locational determinants for large and small firms. The results presented later in this study are consistent with their research.

Two papers by Christy and Ironside are important because they investigate Alberta's advanced technologies. In the first paper, "High Technology Firms in Alberta: Some Locational Considerations", they found that the availability of skilled labour was an important factor for only 27% of the firms surveyed.

In contrast, the residence of the founding entrepreneur was the most important factor for two-thirds of the firms surveyed. They explain the result as follows:

> Labour costs are not regarded as significant probably because firms are small in numbers of employees while labour costs can be built into high value products and services. However, the availability of labour skills was regarded as very important though no hiring difficulties were yet experienced by most firms.

The total labour force of the respondent firms was 27,288. However over 20,000 of these people were employed by only four firms. Christy and Ironside then go on to suggest that if the respondent firms were representative of the total population, there would be some 90,000 employed in high technology in Alberta - more than agriculture, petroleum and natural gas or manufacturing. We suggest this represents a serious extrapolation error because it would be very difficult to identify twelve to sixteen advanced technology firms whose average size is 5000 employees.

This Christy and Ironside result points out the difficulty in defining the advanced technologies. Some researchers define "high tech" sectors to be those with above average ratios of R&D to investment. A second definition is based on the proportion of scientists, engineers, and technical employees in the workforce. Both criteria are rather imperfect proxies for the technological sophistication of the

products that the advanced technologies produce and/or use. Most petroleum firms in Alberta could be considered "high-tech" with these definitions and we assume that inclusion of four very large petroleum firms in the sample used by Christy and Ironside explain their results.

Practitioners have fewer concerns with definitional purity and tend to have a commonly accepted set of high-tech areas. Work by Tech Trends Inc. of Austin, Texas is typical in that they define the following ten areas as high tech:

- Computers
- Space and Air
- Robotics
- Telecommunications
- Lasers
- Bioengineering
- Pharmaceauticals
- Medical Technology
- Military Technology
- Advanced Energy Resources

This list is consistent with the list of fields developed by Alberta Technology, Research and Telecommunications and used in this study (See Chapter 1 for a list of the eight fields).

Christy and Ironside's second paper, "Promoting High Technology Industry: Location Factors and Public Policy" built on the results of their first paper and presents the following conclusions:

- The highest priority government policies should encourage investment by, for example, low taxes on the earnings of new small firms, R & D tax credits or grants where appropriate, and

targetted procurement by government departments and universities.

- Of the same order of priority as the encouragement of risk investment is the need for heavy investment by government in appropriate education and training programs for young people and adult students in universities, colleges as well as in the work place.

- The need for higher levels of education and skills in high technology areas is increasingly evident, although experience and business management are also necessary for success.

- A lower priority for governments should be to invest heavily in information and advisory services, particularly in marketing and business management.

Parallelling the academic research have been a number of policy studies by governments. For example, the Ontario Task Force on Employment and New Technology commissioned a major evaluation that was published in twenty-one volumes. Recognizing that traditional job patterns will change as new technology takes hold, the Government of Ontario established the Task Force to examine the relationship between employment and technology. Their work had several dimensions.

- Research pertaining both to past and future employment was conducted at the level of the industry, the industry-sector, and the overall economy in order to consider the impact of technology on employment from several perspectives;

- A survey based on personal interviews studied future employment in key manufacturing and service industries;

- Estimates of future employment for all industry-sectors were obtained through a survey of informed sources. In addition, occupational shifts over the past decade were studied and estimates made of future occupational profiles for all industry-sectors. In this way, the effect of technology on skills was measured and estimations made of overall employment and occupational shifts for the future;

- At the level of the overall economy, the changes in technology and the effect of additional productivity improvements were examined.

Some of the Task Force's key findings were:

- A significant level of new technology has already been adopted.

- Plans for new technology adoption are extensive for 1985-1990, encompassing a greater range of technologies and faster rates of adoption than in the past.

- Plans for 1990-1995 are more difficult to interpret because few of the industries surveyed plan that far ahead.

- The extensive plans for adopting new technology signal substantial employment-related changes for the coming years.

- Of the major occupational groups, only two - Natural Sciences, Engineering and Mathematics; and Services - are expected to account for a significantly larger share of overall employment growth during the next decade than in the 1970s.

- Generally, firms believe that the adoption of new technology will require employees to have more skills. Increased training will be

needed to achieve proficiency, and employees will need to know more about their organization's operations.

- A wide range of managerial, professional, technical, and skilled trades personnel were identified as needing higher skills and more training to do their work in the future. Many industries expect shortages of these people.

- At the same time as the economy will be needing more highly-skilled people, the industry-sector studies show there will also be an increasing demand over the next decade for relatively lower-skilled workers, such as service workers in fast growing service industries.

- The changing employment growth patterns, with demand growing simultaneously for highly-skilled workers and relatively lower-skilled workers and shrinking demand in areas such as clerical work, have important implications for labour force participants and for skill development policies and initiatives. Both the individuals preparing for entry or re-entry to the labour market, and those industries and institutions providing skill development and training will need to assess these patterns.

Concurrently, the Canadian Advanced Technology Association undertook a major strategic planning exercise of its own, culminating in "The Report of the National Technology Policy Round Table". The following conclusions and recommendations particularly relevant to improving Alberta's human resource capabilities in the advanced technologies were identified.

o Base of Competence

We have pockets of outstanding research capability, advanced technological strength and sophisticated production systems in established industrial sectors in Canada. However, at all stages of the innovation chain, our national base of competence is small.

o Broadening Technical Education

There is also a need to broaden the educational expertise of scientists, engineers and technologists by giving them a deeper appreciation of the market and business aspects of their chosen fields. Few institutes of higher learning now provide this type of exposure.

o Practical Industry/Education Links

There is an urgent need to build practical links between educators and industry. These initiatives might usefully be targeted on decision-making points in the career selection process.

For example, the innovative and highly successful, industry supported, Shad Valley summer program might be expanded into a "new Katimavik". This university-based program is designed to foster entrepreneurial spirit among highly motivated secondary school students as they prepare themselves for post-secondary education. At the university and college levels, greater experimentation with cooperative education should be encouraged. Entry into the private sector following graduation might be facilitated through an expansion of internship programs.

- Consultation

  The effective management of the industry/education interface requires stronger consultative mechanisms. Some universities and colleges have established industry advisory committees. Others might benefit from this model. Industry contact also has to be extended throughout the entire education chain. It is highly unlikely that educational institutions and educators will make significant strides forward unless industry cooperates in such areas as targeting curriculum reform, assisting with teacher training needs, and helping shape the career orientation of students.

- Training and Retraining for a Lifetime of Learning

  There is a growing problem keeping graduates up to date with advances in their disciplines once they enter the workplace. In this respect, we must recognize the speed of technological change and pay more attention to methods for keeping our human capital at the highest possible level of competitiveness. This is perhaps best accomplished through technology upgrading or retraining courses offered on an outreach basis by post secondary institutions.

Finally, the Ontario Premier's Council prepared a brief on "Competing in the New Global Economy." They adopted as a model of the economy, the traditional economic theory of an export base with a supportive domestic segment. While this model is an oversimplification of how an economy operates and has fallen into some disfavour in academic circles, the report nevertheless contains some useful comments and recommendations for this study.

- Canadian firms in the emerging and high-growth sectors operate at a serious disadvantage relative to their international competitors.

In software, Canada's trade deficit is $2 to $3 billion annually. An opportunity still remains to nurture an indigenous software industry. But once again, the opportunity could be missed unless government uses its massive purchasing power as a tool for industrial development.

- The inadequacies of Canada's R&D effort have been well documented. Overall, Canada spends roughly half as much on R&D as a proportion of its gross domestic product (GDP) as the leading industrialized countries. Accordingly, the Council recommends that:

  a) Government should involve the private sector more effectively in university and government research, and ensure that industrial priorities play a much more important role in guiding such research.

  b) Ontario should establish a Technical Personnel Assistance Program, which would subsidize the new hiring of technicians, engineers, and scientists by qualifying Ontario companies with sales of less than $100 million annually.

- More co-op programs are needed at the <u>high school level</u> to ease the transition from classroom to workplace.

- Industrial training is an important element in the educational process and, despite much lip-service, there is not enough of it. Most training is carried on by a few major employers in selected industrial sectors, and most training programs are less than five years old.

These studies highlight some of the work being done in the advanced technology area. The research all points to the critical need for a study of Alberta's current human resource capabilities and future requirements in the advanced technologies. In the next two chapters we review the current resources in the province in terms of both its people and the infrastructure to support the advanced technologies. We then present the results of the survey conducted as part of the study.

4.0 PROFILE OF THE ADVANCED TECHNOLOGY LABOUR MARKET IN ALBERTA

4.1 The Size of Advanced Technology Firms

As of February, 1988, Alberta Technology, Research and Telecommunications estimated that there were 733 advanced technology firms in Alberta. Exhibit 4.1 presents some information on both the total employment in these firms and the number engaged in research and development. For example, 278 firms have 1-4 employees devoted to R&D related activities and 359 firms have some R&D employment.

EXHIBIT 4.1

EMPLOYMENT - DISTRIBUTION OF FIRMS
TOTAL AND R&D RELATED

Number of Employees	Number of Firms Per Class	
	Total Employees	R&D Related Employees
1-4	172	278
5-9	123	51
10-19	80	18
20-49	64	11
50-99	37	0
100-199	17	1
200-499	17	0
500+	6	0
	516	359
Zero or Declined to Specify	217	374
	733	733

(Note: it is not possible to distinguish between firms with zero employees in total or in R&D and firms that declined to answer)

If the midpoint of the employment class is used as a point estimate, the 516 responding firms would have a total employment of 19260. This works out to an average size of 36 employees with the median firm having eight employees. Making a second assumption that the 217 non-responding firms had the same size distribution, total advanced technology employment would be approximately 27,500 people.

Using the midpoint for an employment class is probably optimistic, given the skewed nature of most firms size distributions. The 27,500 is therefore an upper bound for the total advanced technology employment. The lower end for each employment class as the point estimate provides a lower bound of 18,200. (Note the differences between these estimates and those of Christy and Ironside.) Similar procedures allow for estimates to be made of the number of people engaged in research and development.

Using the data in Exhibit 4.1, we expect the R&D related employment to be between 2100 and 3600 people.

Exhibit 4.2 provides information of the distribution of annual sales revenue and the distribution of research and development related expenditures. Again, a significant proportion of the firms which declined to provide the data, had either no revenue or no R&D expenditures.

These figures give some understanding of the mix of advanced technology firms in terms of total employment, R&D related employment, revenues, and R&D expenditures. The next several pages provide data on Alberta's overall labour market upon which the advanced technologies can draw.

EXHIBIT 4.2

DISTRIBUTION OF FIRMS
ANNUAL REVENUES AND R&D EXPENDITURES

Annual Revenues		R&D Expenditures	
Revenue Class	**No. of Firms**	**Expenditure Class**	**No. of Firms**
< $1 million	243	< $50,000	145
$1 m - $2.5 m	65	$50,000 - $100,000	53
$2.5 - $5 m	39	$100,000 - 200,000	67
$5 m - $10 m	21	$200,000 - 400,000	22
$10 m - $25 m	27	$400,000 - $1 m	22
$25 m - $50 m	5	$1 million +	20
$50 million +	10		
	410		329
Declined to Respond	323	Declined to Respond	404
	733		733

4.2 Population

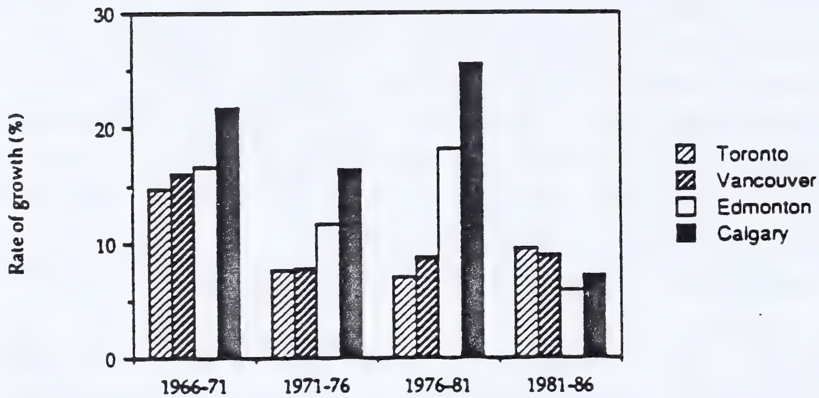
Albertans comprise approximately one-tenth of Canada's 25 million people. The province's population has grown rapidly and steadily since the first European settlers arrived in the 1800's and overall, there has been generally continuous growth, higher than elsewhere in Canada.

Calgary and Edmonton's growth rates have varied considerably, but they too have been more rapid than other Canadian cities (Exhibit 4.3). With two-thirds of Alberta's population living in these two cities, Edmonton's population is over 785,000 while

Calgary's approaches 700,000. The two are the fifth and sixth largest cities in Canada when using Canadian Metropolitan Area definitions.

EXHIBIT 4.3

POPULATION GROWTH RATES IN CANADIAN CITIES

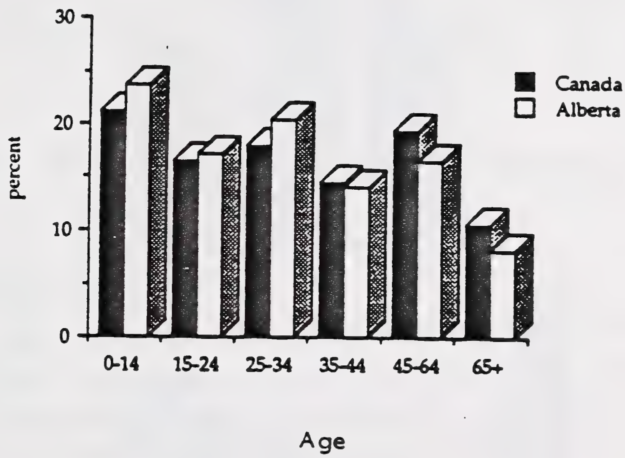


Statistics Canada, 1986

Albertans are young, with the highest proportion of working age people, and the lowest proportion of seniors in Canada (Exhibit 4.4). Nearly one-half of Albertans are under 25, both appropriate and ready for training in advanced technology. This young and, as will be shown shortly, well educated population is very unusual in the world - North American and European populations are generally much older, and Asian populations, while young, are often less well educated.

EXHIBIT 4.4

PROPORTION OF WORKING AGE POPULATION BY AGE GROUP



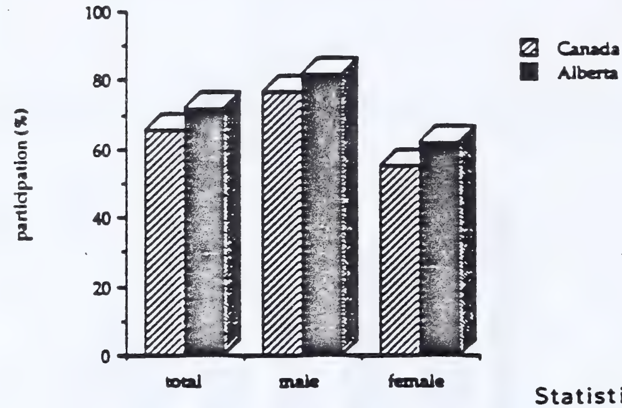
Statistics Canada, 1986

4.3 Alberta's Labour Force

Albertans are the second most highly employed group in Canada (Exhibit 4.5). Moreover participation rates for both men and women have been consistently higher than elsewhere in Canada and internationally. The number of people employed in Alberta increased by 75 percent between 1971 and 1984, compared to an increase of one-third for the rest of Canada.

EXHIBIT 4.5

LABOUR FORCE PARTICIPATION RATE 1986

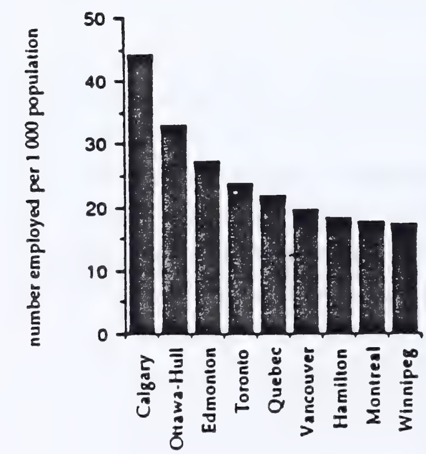


Statistics Canada

Over half of all Edmontonians and Calgarians are employed in managerial, professional or clerical occupations. The two cities are among the major Canadian centres of employment in natural science, engineering and mathematics (Exhibit 4.6). Moreover, Alberta has one of the largest pools of scientific engineering expertise per capita in the world.

EXHIBIT 4.6

EMPLOYMENT IN MATH, SCIENCE, AND ENGINEERING



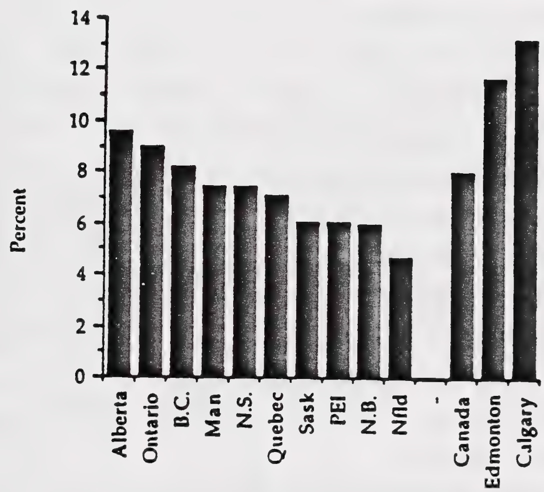
Statistics Canada, 1981

4.4 Education

Albertans are among the most highly educated populations in the world. Alberta has the highest proportion of people of any Canadian province with university degrees (Exhibit 4.7). Moreover, with only ten percent of Canada's population, Alberta produces nearly one-quarter of the nation's apprentices.

EXHIBIT 4.7

PERCENTAGE OF UNIVERSITY DEGREE HOLDERS BY PROVINCE



Statistics Canada, 1981

Albertans also participate extensively in adult education; Calgary and Edmonton have the highest participation of anywhere in Canada. In addition, Alberta has the highest proportion of attendees of job-related adult education in Canada. These statistics indicate a strong willingness to continue advanced training and retraining to meet changing workforce requirements.

4.5 Post Secondary Graduate Statistics

4.5.1 Institutions and Programs

The source of new skilled labour for the advanced technologies is Alberta's post secondary education system which includes four universities, three technical institutes, ten community colleges and four vocational centres.

Institute	Location
University of Alberta	Edmonton
University of Calgary	Calgary
University of Lethbridge	Lethbridge
Athabasca University	Athabasca
Northern Alberta Institute of Technology	Edmonton
Southern Alberta Institute of Technology	Calgary
Westerra Institute of Technology	Stony Plain
Fairview College	Fairview
Grande Prairie Regional College	Grande Prairie
Grant MacEwan Community College	Edmonton
Keyano College	Fort McMurray
Lakeland College	Vermilion
Lethbridge Community College	Lethbridge
Medicine Hat College	Medicine Hat
Mount Royal College	Calgary
Olds College	Olds
Red Deer College	Red Deer
Alberta Vocational Centre	Calgary
Alberta Vocational Centre	Edmonton
Alberta Vocational Centre	Grouard
Alberta Vocational Centre	Lac La Biche

Athabasca University focuses on distance education and therefore does not have a campus population.

In addition to the public system, there are five accredited independent colleges (Alberta College, Edmonton; Camrose Lutheran College, College Heights; Concordia College, Edmonton; and King's College, Edmonton) as well as numerous private schools which offer courses in specialized subjects such as computer software, oil well drilling etc..

In 1983, Alberta Manpower (later renamed ACDE) produced a report, Post-Secondary Education Programs, which outlined all of the programs available by institution, their length and entrance requirements. Graduates from almost any program with the right attitude could find employment in the advanced technologies but the most relevant programs are identified in Exhibit 4.8. This list is not intended to be exhaustive and new programs may have been added in the last few years. However it does provide an appreciation of the range of programs available in Alberta that are applicable to the advanced technologies.

4.5.2 Graduate Student Statistics

The difficulties discussed earlier in defining the advanced technology fields represents a serious impediment to identifying the number of graduates each year that might have skills and training relevant to the advanced technologies. Detailed information specific to these fields does not exist. More general information must be drawn from several sources to provide a broad understanding of the capabilities of the labour force entrants. The approach taken here is to move from broad

EXHIBIT 4.8

ALBERTA POST-SECONDARY INSTITUTIONS AND PROGRAMS

	University of Alberta	University of Calgary	University of Lethbridge	Athabasca University	NAIT	SAIT	Westerra	Lethbridge C.C	Medicine Hat	Mount Royal	Olds	Red Deer	Grant McEwan	Fairview	Lakeland	Grande Prairie Regional	Keyano	Alberta College	Camrose Lutheran	Canadian Union College	Concordia	Kings College	AVC Calgary	AVC Edmonton	AVC Glouard	AVC Lac La Biche
Job Readiness									x						x	x									x	
Pre Careers					x	x																				
Vocational Prep.															x		x								x	x
Vocational Skills												x		x		x										
Agriculture Engineering/ Technology	x										x															
Agronomy											x			x												
Animal Health Tech					x	x					x			x	x											
Pre Veterinary Medicine	x	x	x						x	x		x				x	x		x		x					
Biochemistry	x	x																								
Biological Sciences			x																	x						
Biological Sciences Tech.					x							x														
Biotechnology						x																				
Genetics	x																									
Microbiology	x		x																							
Business Administration	x	x		x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	x	x	x
Management	x	x	x		x				x	x			x													
Telecommunications					x	x																				
Broadcast Electronics						x																				
Computer Engineering	x	x			x	x																				
Computer Management													x													
Computer Programming	x				x	x			T			x				x										
Computer Science	x	x						x	T	x						T			T		T					
Engineering	x	x	T						T	T		T				T										
Engineering Design					x	x			T																	
Engineering Technologies					x	x	x	x																		
Medicine	x	x																								
Medical Lab Technicians	x				x	x																				
Nuclear Medicine Tech.						x																				
Mathematics	x	x	x																							
Statistics	x	x																								
Environmental Science								x																		
Chemical Technicians					x	x						T														
Chemistry	x	x	x																							
Environmental Quality Control										x																
Physics	x	x	x																							
Electrical Trades									x							x	x	(Also Apprenticeship Prog.)								
Tool & Dice Making																		(Apprenticeship Prog.)								
Welding						x		x	x					x	x	x	x	(Also App. Prog.)							x	x

T - Transfer program to either University of Alberta or University of Calgary.

Alberta statistics to detailed information on placements by field of study and industry albeit at the national level to similar statistics at the Alberta level but for graduates from colleges and technical institutes only. Taken together this information present a reasonably comprehensive picture of the skills and capabilities being brought to the market.

First the annual flows of graduates from post-secondary institutions is shown in Exhibit 4.9. Two items on this chart are noteworthy - the low unemployment levels and the high percentage of university students going into the public sector. To explore this latter result more fully, we first present more detailed information on graduates by broad field of study (Exhibit 4.10) and then Statistics Canada information on occupations and receiving industries for Alberta graduates (Exhibit 4.11). The first highlights the high proportion of university graduates in the field of education while the second highlights the services-orientation of most Alberta graduates. Note that industries with a high technology component are virtually absent from this second exhibit.

In an effort to identify more subtle movements to industry of graduates by field of study, more detailed information is presented in Exhibits 4.12, 4.13, and 4.14. These represent the movement of university graduates, training and vocational certificate holders, and diploma and certificate holders respectively from across Canada for 1984. (The tables must be read horizontally, that is "In what industries did the graduates from these fields of study find related work?"). Several key points emerge from these very detailed tables. The first is the large number of fields of study which may provide graduates with appropriate training for the advanced technologies. Second it is important to note the diversity of industries

EXHIBIT 4.9

ANNUAL FLOWS OF THOSE GRADUATING FROM POST-SECONDARY EDUCATIONAL INSTITUTIONS ALBERTA - 1986

Institutional Type	Graduates	Destination					
				To Labour Force			
		To Further Education	To Household Or Migration	Total	Public Services	Private Sector	Unemployed
University	9 000	1 300	800	6 900	3 900 (56%)	2 600 (37%)	400 (7%)
College/Technical	10 000	700	400	8 900	1 300 (15%)	6 700 (75%)	900 (10%)
TOTAL	19 000	2 000	1 200	15 800	5 200	9 300	1 300

(Source: Alberta Career Development and Employment)

EXHIBIT 4.10

UNIVERSITY GRADUATES BY MAJOR FIELD OF STUDY
ALL LEVELS, ALBERTA, 1985-86

Education	2 510
Fine Arts	253
Humanities	530
Social Sciences	2 889
Natural Sciences	1 519
Engineering	879
Health	942
Other	2
TOTAL	9 524

Source: Alberta Advanced Education

COLLEGE AND TECHNICAL INSTITUTE GRADUATES
BY MAJOR FIELD OF STUDY
(Career Programs Only)
Alberta, 1985-86

Arts & Sciences (General)	19
Fine & Applied Arts	608
Humanities	90
Health Sciences	882
Engineering & Applied Sciences	2 177
Natural Sciences & Primary Industries	841
Social Sciences & Services	1 195
Business & Commerce	2 276
TOTAL	8 088

Source: Post-Secondary Graduate Employment Follow-up Survey

EXHIBIT 4.11

NATIONAL GRADUATES SURVEY
OCCUPATIONS AND INDUSTRIES OF GRADUATES
EMPLOYED SIX MONTHS OR MORE
(As Of June, 1984)
** ALBERTA **

	Top Four Occupations	% of Graduates In Occupation	Top Four Industries	% of Graduates In Industry
Graduates	1. Teaching & Related	31%	1. Education Service	47%
	2. Management, Admin., etc.	25%	2. Government Service	16%
	3. Natural Science, Engineering & Math.	21%	3. Health & Soc. Services	9%
			4. Business Service	9%
	4. Social Sciences & Related	15%		
		....		....
	Subtotal	92%	Subtotal	81%
Undergraduates	1. Teaching & Related	23%	1. Education Service	26%
	2. Natural Science, Engineering & Math.	18%	2. Health & Soc. Services	20%
			3. Government Service	12%
	3. Medicine & Health	15%	4. Business Service	[illegible]
	4. Management, Admin., etc.	12%		
		....		....
	Subtotal	69%	Subtotal	59%
Career/Technical Diploma/Cert.	1. Clerical & Related	17%	1. Health & Soc. Services	13%
	2. Management, Admin., etc.	12%	2. Business Service	12%
	3. Natural Science, Engineering & Math.	10%	3. Retail Trade	10%
			4. Construction	8%
	4. Service	9%		
		....		....
	Subtotal	48%	Subtotal	43%
Trades/Vocational Certificate	1. Medicine & Health	22%	1. Health & Soc. Services	25%
	2. Clerical & Related	21%	2. Government Service	11%
	3. Service	10%	3. Manufacturing	[illegible]
	4. Fabr. Assem., Repair	8%	4. Retail Trade	[illegible]
		....		...
	Subtotal	61%	Subtotal	[illegible]

Source: Statistics Canada

EXHIBIT 4.12

FIELD OF STUDY BY INDUSTRY OF RELATED OCCUPATION

UNIVERSITY GRADUATES

Undergraduate and Graduate Degree Holders - Canada, 1984

"In what industries did the graduates from these fields of study find related work?"

Industry

Field of Study	Total Graduates	Estimated Number of Graduates in Related Occupations	Estimated Percentage of Grads in Related Occupations	Agriculture	Fishing & Trapping	Logging & Forestry	Mining, Quarrying & Oil Wells	Manufacturing	Construction	Transportation	Communication & Other Utilities	Wholesale Trade	Retail Trade	Finance and Insurance	Real Estate & Insurance Agents	Business Service	Government Service	Education Service	Health & Social Service	Accommodation, Food & Beverage	Other Service
	84760	80928	82.7																		
Elementary / Secondary Teacher	10716	10580	91.7					•	•	•	•		•	•		•	•	87.8	•	•	•
Post-Secondary Teacher	287	330	96.7					•			•		•					88.1	•		
Kindergarten / Preschool Teacher	590	578	89.0															94.6	5.4		
Other Teaching	3770	3034	87.9					•		•			•	•	•	•	11.8	58.4	9.6	•	14.1
Fine & Applied Arts	3027	2250	69.8					5.4	•		•		6.8	•	•	•	9.0	54.3	6.6		7.4
Language / Linguistics	7840	6139	87.4	•		•	•	6.5	•	•	•	•	•	•	•	7.6	11.1	47.5	•	•	•
Journalism / Mass Communications	1377	1170	82.7				•	12.9	•	•	30.0		•	•		10.9	14.7	11.1	•		13.6
Philosophy / Religion	1621	1598	88.3					•				•	•	•	•	•	9.5	33.0	6.7	•	35.4
Business, Commerce & Admin.	11009	12201	89.7	•		•	•	15.7	•	•	•	6.1	6.0	7.9	•	29.1	12.0	•	•	•	•
Law	3080	3049	96.1				•	•		•	•		•	•	•	80.4	10.7	•			
Social Work	1414	1620	90.9													•	8.0	5.2	79.0		7.0
Other Social Sciences	15814	12085	87.9	•	•	•	•	5.4	•	•	•	•	5.3	8.9	•	7.3	19.1	24.3	15.1	•	•
Veterinary Medicine Science	240	241	93.8	76.2									•				11.0	8.5			
Household Science	776	704	85.0	•									12.8	5.9			7.2	22.6	38.4	7.2	•
Other Agriculture	4330	3750	75.4	6.6	•	•	•	15.1	•	•	•	•	•	•	•	•	19.3	24.2	14.2	•	•
Architecture & Landscape	615	635	94.9	•					10.4	•		•		•		62.1	11.6		•		5.2
Chemical Engineering	599	666	92.4				23.7	44.0	•		8.9	5.2			•	7.4	•	•			
Civil Engineering	1369	1472	92.9				•	6.1	27.7	•	•	•	•		•	31.4	17.4	•	•		•
Electrical Engineering	1090	1212	94.2				•	41.1	•		24.0	•				18.7	6.3	•	•		
Forestry	463	449	88.6	•		45.4		7.5	•		•						23.0	11.5			6.0
Mechanical Engineering	1537	1426	87.2	•		•	11.2	35.7	•	•	11.7	5.5				15.7	7.9	•	•		•
Other Engineering	1742	1796	91.1	•			9.7	34.2	•	•	5.6	•	•			18.1	12.7	8.5	•	•	•
Dentistry	527	552	100.0														20.5	6.8	72.6		
Medicine	2089	2314	93.8					•									•	5.5	90.8		
Nursing	2063	2012	93.5					•								•	5.7	10.4	83.1		
Rehabilitation Medicine	763	866	99.7														•	5.3	93.1		
Other Health	1037	1190	96.1					•		•			57.4				•	•	35.3		
Computer Science	1809	1810	92.8				•	11.7	•	•	5.8	6.5	5.3	8.8		26.5	14.1	12.6	•		•
Other Mathematics / Science	3150	3079	82.9	•			13.4	15.1	•	•	•	•	•	7.0		20.8	9.9	22.2	•	•	•

All data pertain to the occupation/industry of June, 1984, two years after graduation.

• - The available data is unreliable.

• - The percentage is less than 5% of the total graduates in related employment.

Source: Statistics Canada, National Graduates Survey, 1984

EXHIBIT 4.13

FIELD OF STUDY BY INDUSTRY OF RELATED OCCUPATION

VOCATIONAL TRAINING CENTRES AND COLLEGES

Trade and Vocational Certificate Holders - Canada, 1984

"In what industries did the graduates from these fields of study find related work?"

Industry

Field of Study	Total Graduates	Estimated Number of Graduates in Related Occupations	Estimated Percentage of Grads in Related Occupations	Agriculture	Fishing & Trapping	Logging & Forestry	Mining, Quarrying & Oil Wells	Manufacturing	Construction	Transportation	Communication & Other Utilities	Wholesale Trade	Retail Trade	Finance and Insurance	Real Estate & Insurance Agents	Business Service	Government Service	Education Service	Health & Social Service	Accommodation, Food & Beverage	Other Service
	55247	34307	62.1																		
Arts General	460	184	40.0				23.8	22.6	31.0				22.6								
Applied Arts	3626	2407	66.4	•				18.5			•	•	13.9		•	•	•	•	•	•	31.4
Humanities	0	●	●																		
Nursing	2798	2526	90.3				•	•					•			•	•	•	95.3	•	•
Medical Technology	701	571	81.4					•									•	•	90.5	•	
Medical Equipment	0	●	●																		
Other Health	67	67	100.0														17.9	9.0	73.1		
Chemical Technology	70	●	●					●									●				
Electrical Technology	3619	2067	57.1	•	•		•	37.7	11.9	•	9.2	12.1	8.5	•	•	•	•	•	•	•	•
Transportation Technology	324	196	60.4		•			10.6	•	49.0	•	•					•	19.2			•
General Engineering	2096	1030	49.5				•	61.0	10.8	•	•	•	12.3			15.6	5.6	•		•	•
Mathematics & Computer Science	1274	809	63.5					20.0			5.6	•	5.4	5.4	•	13.0	27.9	8.0	•		7.9
Mechanical Engineering	7629	4219	55.3	•	•	•	•	26.2	5.9	6.9	•	8.9	27.4	•	•	•	5.9	•	•	•	•
Architectural Engineering	7609	3954	52.0	•	•	•	•	41.4	24.3	•	•	•	•	•	•	•	6.4	•	•	•	7.3
Aeronautical Engineering	0	●	●																		
Industrial Engineering	3866	1838	47.5	•		•	•	67.4	•		5.4	•	6.7			•	•	•	•	•	•
Natural Sciences	1644	1012	61.5	12.1				8.1	6.4			•	37.8			•	•	•	•	•	•
Other Primary Industries	535	218	40.7	•	•	13.3	46.9	8.0	8.0	•						•	•			6.2	
Resource Processing Technology	254	159	62.5			•	•	55.9	8.8			9.0					•	•			6.9
Environment Technology	103	57	55.5			●		●	●		●						●				
Protection & Correction	58	●	●														●	●	●		
Social Services	418	372	89.0							•			•			•	7.0	•	81.4		•
Recreation	246	156	63.3					•									27.8		20.9	7.8	41.7
Education & Counselling	180	169	93.8						•				9.8					17.9	70.5		
Social Science	24	●	●																●		
Secretarial	10290	7032	68.5	•			•	8.8	•	•	•	6.5	9.4	10.6	•	13.1	17.3	•	10.2	•	•
Management & Administration	2677	1979	73.9			•	•	7.6	•	•	•	9.0	12.5	10.0	•	9.6	11.9	•	15.0	5.8	•
Merchandising & Sales	612	379	62.0	•		•		•	5.9			12.4	65.1	•					•	•	
Service Technology	4067	2769	68.1			•	•	6.6		•		•	6.1			•	•	•	11.6	67.1	•

All data pertain to the occupation/industry of June, 1984, two years after graduation.

● - The available data is unreliable.

• The percentage is less than 5% of the total graduates in related employment

Source Statistics Canada, National Graduates Survey, 1984

EXHIBIT 4.14

FIELD OF STUDY BY INDUSTRY OF RELATED OCCUPATION
COLLEGE AND TECHNICAL INSTITUTE GRADUATES
Diploma and Certificate Holders - Canada, 1984

"In what industries did the graduates from these fields of study find related work?"

Field of Study	Total Graduates	Estimated Number of Graduates in Related Occupations	Estimated Percentage of Grads in Related Occupations	Industry: Agriculture	Fishing & Trapping	Logging & Forestry	Mining, Quarrying & Oil Wells	Manufacturing	Construction	Transportation	Communication & Other Utilities	Wholesale Trade	Retail Trade	Finance and Insurance	Real Estate & Insurance Agents	Business Service	Government Service	Education Service	Health & Social Service	Accommodation, Food & Beverage	Other Service
	53989	44569	82.6																		
Arts General	30	ø	ø																		
Applied Arts	4444	3100	69.8	•				27.3	•	•	11.1	•	17.7	•	•	15.9	•	8.1	•	•	6.9
Humanities	712	578	81.2					19.5		•	•	•	•			6.3	17.9	44.2	•	•	•
Nursing	6486	6333	97.6				•	•				•		•		•	•	•	96.0	•	•
Medical Technology	2851	2737	96.0	•				•				•	•			•	•	•	90.7		
Medical Equipment	68	68	100.0					66.7					22.2						11.1		
Other Health	451	352	78.2	•				11.3					•				10.6	18.4	40.1	10.3	5.7
Chemical Technology	624	514	82.4	•			•	50.2		•	•	•	•			10.3	7.8	9.6	12.1		
Electrical Technology	3781	3123	82.6				•	29.2	•	•	17.6	13.7	6.3	•	•	9.5	8.8	•	•		•
Transportation Technology	425	320	75.2		•		•	17.6		47.2	•	•	•	•		•	13.4	•		•	6.5
General Engineering	1917	1476	77.0			•	6.1	22.5	10.1	•	•	•	•	•	•	23.9	18.1	•	•	•	•
Mathematics & Computer Science	2382	2004	84.1	•		•	•	15.0	•	•	7.1	8.0	•	13.3	•	21.1	14.5	6.9	•	•	•
Mechanical Engineering	1645	1228	74.6	•	•	•	•	38.2	5.0	12.0	•	8.8	8.5		•	•	11.0	•	•	•	•
Architectural Engineering	1730	1282	74.1				•	12.8	21.9	•	•	•	•	•	•	28.0	14.4	•	•		•
Aeronautical Engineering	16	ø	ø					ø		ø											
Industrial Engineering	688	501	72.8			•	•	73.2	•		•	•	7.0	•		5.2	•				•
Natural Sciences	1367	1060	77.5	43.6	•	•		12.4	•	•	•	5.6	5.9	•		•	16.1	•	•	•	•
Other Primary Industries	810	578	71.3	•	•	22.2	28.7	5.0	•	•	•	•		•		•	23.2		•		•
Resource Processing Technology	479	420	87.7	•		30.3		26.0	•	•		•				6.5	25.7				•
Environment Technology	381	226	59.3	•		7.7	•	•	•		•	•				9.8	54.6	•	5.2	•	
Protection & Correction	1237	936	76.1		•		•	•		•	•		6.0	•	•	9.5	63.4	•	6.5	•	•
Social Services	1537	1315	85.6					•		•			•	•		•	9.4	8.9	72.6	•	•
Recreation	1143	914	80.0					•	•	•	•		•	•	•		16.4	7.8	17.2	7.4	37.7
Education & Counselling	2273	2010	88.4					•		•		•	•	•		•	•	14.7	71.8	•	•
Social Science	281	265	94.3						•						•	6.7	13.5	•	62.9		6.7
Secretarial	5238	4592	87.7	•			•	8.6	•	•	•	•	•	12.5	•	20.1	12.2	6.1	14.1	•	•
Management & Administration	8461	6658	78.7	•		•	•	11.9	•	•	•	7.3	16.9	10.0	•	11.2	11.3	•	•	9.0	5.2
Merchandising & Sales	1757	1386	78.9	•				16.7		•	•	11.4	24.7	10.7	10.1	5.9	5.6	•	•	•	•
Service Technology	755	555	73.5	•				•		•		•	•	5.3		•	•	•	7.3	34.5	29.9

All data pertain to the occupation/industry of June, 1984, two years after graduation

ø - The available data is unreliable.

• - The percentage is less than 5% of the total graduates in related employment

Source: Statistics Canada, National Graduates Survey, 1984

graduates of each field of study entered. Finally, the proportion of graduates that enter the manufacturing industry reflects the strength of manufacturing in the Ontario labour market.

In an attempt to reflect more accurately the Alberta labour situations for graduates entering the advanced technologies, results for a subset of educational programs were drawn from the Post-Secondary Graduate Employment Follow-up Survey - Alberta College and Technical Institutes, 1985. This survey was done by HLA Associates on behalf of Alberta Career Development and Employment. All graduates from the thirteen Alberta colleges and technical institutions completing technical and career related programs of study during the 1984-85 academic year were included in the survey. In total, there were 235 different programs that lasted 32 or more weeks, excluding university transfer, academic upgrading, pre-technology or pre-employment, apprenticeship and non-career programs, included in the survey.

For the purposes of this advanced technology study, 123 of these programs were identified as being appropriate for the advanced technologies. These involved 3097 of the total student population of 7622 or 41% and represents 2454 or 44% of respondents.

The subset of programs included the following ten broad categories.

Commercial Art (including Commercial Arts and Other Graphic/Audio Visual Arts);

Medical Lab (lab technicians);

Chemical Engineering (including biotechnology, chemical technologies, chemical engineering technicians);

Electrical;

Computer Science;

Civil Engineering (including civil technicians, design and drafting, instrumentation, mechanical engineering, welding and industrial design);

Agriculture (agricultural technicians, scientists and engineers);

Petroleum Resources (resource technicians)

Environmental (environmental control and water science technology);

Business (including accounting, marketing and business administration).

The number of graduates by broad category are shown in Exhibit 4.15 along with the average starting salary per group. The exhibit shows a relatively high proportion of male graduates, especially in the more technical fields. The average salary for the college and technical institute graduates in this sample is \$17,508 and the salaries range from \$12,933 to \$20,245 per year. The average age of these graduates is 24.49 years. Comparable data for university graduates would show higher starting salaries but it is difficult to speculate on the distribution across relevant academic fields.

EXHIBIT 4.15

NUMBER OF RESPONDENTS BY FIELD OF STUDY PLUS AVERAGE SALARIES

	Female	Male	Total	Percent of Total	Average Annual Salary
Commercial Arts	56	26	82	3.3%	$12,933
Med Lab	73	35	108	4.4	20,245
Chemical Eng.	21	44	65	2.7	17,165
Electrical	7	406	413	16.9	17,716
Computer Science	69	104	173	7.1	17,858
Civil Eng.	35	402	437	17.9	19,409
Agriculture	13	74	87	3.6	17,161
Petroleum Resources	16	86	102	4.2	19,079
Environment	15	123	138	5.6	18,179
Business	467	371	838	34.3	15,333
Total	772	1671	2443	100%	$17,508

(Data was missing for 9 respondents)
Source: Alberta Career Development and Employment. Post-Secondary Graduate Follow-up Survey, 1985.

To identify the mix of occupations and industries available to Alberta graduates, information was developed by field of study for the occupations obtained using the Standard Occupational Classification, 1980 (SOC) and by SIC code for the industries. These are presented in Exhibits 4.16 and 4.17. Again the breadth of occupations and industries is noteworthy. Second, the number of students entering natural sciences and engineering occupations is high and reflects the orientation of the technical institutes. Finally the number of students entering the manufacturing industries is large especially considering the small size of the manufacturing sector in Alberta.

EXHIBIT 4.16

FIELD OF STUDY BY OCCUPATION (1)

ALBERTA COMMUNITY COLLEGE AND TECHNICAL INSTITUTE GRADUATES

	Management Admin.	Natural Sciences & Eng.	Medicine and Health	Art, Liter. and Rec.	Clerical and Related	Sales	Services	Farming	Mining, Oil & Gas	Processing	Fabrication & Assembly	Construction Trades
Commercial Arts		5		49	3	16	5				5	
Medical Lab.		9	70		3		3	3				
Chemical Eng.		57	4			6	6			8	8	
Electrical	4	24			5	9					33	12
Computer Science	4	67			12	5						
Civil Eng.	5	33			8	10				3	15	8
Agriculture	8	15			12	5		43			3	7
Petroleum Res.	6	33			19	6			8	6		
Environment	5	30	4		10	5	12		3			9
Business	24				47	16						

1. In what occupations (by SOC) did graduates of these fields of study find related work?
2. Occupations drawing less than 3% of graduates not indicated or this exhibit.

Source: Alberta Career Development and Employment, Post-Secondary Graduate Follow-up Survey, 1985.

EXHIBIT 4.17

FIELD OF STUDY BY INDUSTRY (SIC)

ALBERTA COMMUNITY COLLEGE AND TECHNICAL INSTITUTE GRADUATES

	Agriculture	Mining, Oil & Gas	Manufacturing	Construction	Transportation	Communications	Wholesale Trade	Retail Trade	Finance & Insurance	Real Estate	Business Services	Gov't Services	Education	Health & Soc. Serv.	Accom., Food, Bev.
Commercial Arts			23			3		18			37		5	5	
Medical Lab.						3						12	4	70	
Chemical Eng.	6	10	33								16	6	8	6	6
Electrical			14	8		12	23	16			9		3		
Computer Science		6	9	4		4	6	10			21	14	11	4	
Civil Eng.		10	15	14	5	4	11	12			15	5			
Agriculture	39			6	3		8	5	15			12	3		
Petroleum Res.		32	5	3		5	3	8		5	16	8		4	3
Environment		6	4	8		9	3	7			10	35	6		
Business		5	7				6	19	9	5	14	9	4	3	6

Industries receiving less than 3% of graduates in a field not identified in the exhibit.
In what industries (by SIC) did graduates of these fields of study find related work?

Source: Alberta Career Development and Employment, Post-Secondary Graduate Follow-up Survey, 1985.

5.0 ALBERTA'S INFRASTRUCTURE FOR ADVANCED TECHNOLOGY

Alberta's geography has necessitated efficient and advanced transportation and telecommunications. Networks of roads, rail and air link Alberta's communities to Canadian and international markets. Telecommunications systems include a public switching network, specialized networks for data transmission, broadcast relay, and private networks throughout the province, and use advanced digital networking and fibre optic technology. The largest mobile radio communications network in North America and two cellular networks were also pilot-tested in Alberta and now form a key communications system within and outside the province.

Developments in energy research have led to a competitive service sector specializing in seismic, geological and geophysical engineering, management consulting, data handling, computer software, and remote sensing.

5.1 Government Facilities

Recognizing the need for a solid support infrastructure for advanced technology, the government has initiated the development of world class science and technology facilities.

One government initiative is the Alberta Heritage Foundation for Medical Research, established in 1979 with a $300 million endowment from the Alberta Heritage Savings Trust Fund. The Foundation's support of basic and clinical research in Alberta hospitals and universities spans a broad spectrum of disciplines, including biochemistry, microbiology, pediatrics, immunology and neurology.

A major stepping stone for research was the creation of the Alberta Research Council (ARC). Established in 1921 to identify Alberta's natural resources and explore methods for developing them, it is now the largest provincial research organization in Canada. The majority of its $40 million budget goes into research and development in six major areas: natural resources, oil sands, coal, industrial and engineering research, advanced technologies, and applied sciences. ARC's Joint Venture Research provides technical advice and assistance to help new companies develop innovative products and processes while launching longer term research in such "cutting edge" sectors as biotechnology and computer-based technologies.

A leader in cold-climate product development and service technology, Alberta's innovation in transportation, urban infrastructure development and energy efficient housing is recognized throughout the more than 30 countries which have experience in winter climate. The Centre for Frontier Engineering Research (C-FER) was established at the University of Alberta in 1983 to solve engineering problems particular to cold-climate energy development. C-FER researches problems related to materials, fabrication, design, regulations, transportation and construction of structures required for arctic and offshore developments. As solutions are found for this challenging environment, C-FER has marketed these technological applications world-wide.

The Alberta Oil Sands Technology and Research Authority provides the private sector and research organizations with financial incentives to develop economically viable and environmentally acceptable petroleum technology for oil sands, heavy oil and enhanced conventional oil recovery.

Out of concern for the environment, and in response to industry-wide needs, a hazardous waste treatment facility has been constructed at Swan Hills. This Special Waste Management Facility is unique in North America in that it is fully integrated with facilities to treat special wastes by physical-chemical treatment, stabilization or incineration.

Other facilities include the Electronic Test Centre, which provides testing and certification of electronics products; the Electronic Industry Information System from which Alberta manufacturers can access the most up-to-date technical and design information available; the Alberta Laser Institute, established to assist industry in implementing laser systems to enhance productivity and competitiveness; the Alberta Telecommunications Research Centre which melds small, "home grown" and large multinational corporations in the area of telecommunications; the Canadian Centre for Learning Systems, which performs research, development, evaluation, teaching and training in all areas of computer-assisted learning; and the Food Processing Development Centre, which helps increase the competitiveness of Alberta's food processors through the application of new technology and the development of new products and processes.

5.2 Research and Development Supporting Advanced Technology

5.2.1 Academic Institutions

Much of Alberta's research and development in advanced technologies originates in the universities and is supported by government-industry joint ventures and financial assistance.

University of Alberta

Medicine, Pharmacy, Engineering, Science, Agriculture and Forestry are the main foci for technology transfer. The Faculty of Engineering has been instrumental in creating new industrial research centres for electronic, telecommunication, laser and energy production technologies, and is conducting research into civil engineering, process control, and cold climate problems. In the Faculty of Science, advanced technology research involves such areas as detection of seismic events, use of microbes to clean up industrial wastes, genetic engineering of native plant species, and biosynthesis of antibiotics. Innovations in biotechnology have led to the creation of several spin-off companies.

Health Sciences accounts for one-half of the sponsored research on campus, in large part because of support from the Alberta Heritage Foundation for Medical Research. Collaboration among the Faculties of Science, Pharmacy, Dentistry and Medicine is resulting in more basic sciences being transferred to clinical medicine where research is applied directly to patient care. For example, medical lasers are being used for removing cancerous tumors and this technology is now being marketed worldwide.

The University of Alberta developed the Alberta Microelectronics Centre, a non-profit corporation established to transfer technology between the University and Alberta industry, in areas like realtime software, semi-custom integrated circuits, robotics and CAD/CAM technology. The Centre recently opened a Calgary office that is working closely with the University of Calgary and southern producers. With a major financial infusion from the provincial government, the AMC recently opened the first

microelectronics production facility in western Canada. This facility will likely be a significant catalyst for the creation of new manufacturing companies and the modernization of the production processes for existing firms.

University of Calgary

The Faculty of Medicine attracts the highest per capita research funding of all Canadian medical institutions. With the highest concentration of reproductive physiologists and one of the largest concentrations of expertise in genetic engineering and biotechnology in Canada, the faculty is achieving dramatic success in medical research. The Cardiovascular Research Group is one of the few in North America to cover the spectrum from laboratory study of single heart cells to clinical research with cardiac patients.

The University also has extensive computer facilities, including one of Canada's three Cray supercomputers. With an objective of encouraging research and training in vector computing technology and developing leading edge application software, the Supercomputer Centre provides a research facility for Canadian universities and is attracting world class academic and industrial research. In a parallel manner, the University's research in microelectronics is strongly oriented toward industrial and commercial needs, spanning the full range from design through application. The University of Calgary also has oil and gas expertise, and much of its research is commercially viable. A large part of their exploration, geological and geophysical research is funded by the Canadian oil and gas industry. Because of the University's close working relationship with industry, its particular strengths and interests often parallel or lead current industry concerns. The Department of Chemical

and Petroleum Engineering is at the forefront of software development for computerized reservoir simulation. The Computer Modelling Group, an industry-sponsored affiliate of the University, was a spin-off from this work and is a commercial leader in reservoir simulation and modelling.

University of Lethbridge

Advanced technology research ranges from agriculture to astrophysics. Exciting developments in infrared spectrophotometry, detection, recording and analysis have led to major improvements in the sensitivity and accuracy of instrumentation with potential applications in industry and medicine. The development and control of gibrillin activity in plant growth promises to have major implications for the control of plant height and crop yields.

Technical Institutes and Community Colleges

Alberta's technical institutes and community colleges including the Northern Alberta Institute of Technology (NAIT), the Southern Alberta Institute of Technology (SAIT) and Westerra and the network of fourteen colleges, offer a diverse set of programs. These include: agricultural engineering, aeronautical engineering technology, avionics technology, biological sciences technology (including biotechnology), electronics, telecommunications, management, business administration, entrepreneurship, computer engineering technology, computer programming and computer science.

Municipal Initiatives

Municipal initiatives include incubators and research parks in both Calgary and Edmonton. Incubators are designed to assist the launching of new businesses by providing access to computers and links to investment contacts and expertise in varied areas of business. They are also intended to reduce the risks and costs for start-up firms by sharing support services.

5.3 Financial Initiatives

The third component that must be addressed with the two preceding support programs is financial support. Below are brief overviews of the key financial support systems.

Vencap Equities Alberta Ltd. (VENCAP) is a $244 million venture capital fund established through the public sale of shares and a loan from the Alberta Heritage Savings Trust Fund. One of VENCAP's mandates is to invest in Alberta corporations with substantial growth prospects and the potential to further diversify the economy. It must nevertheless follow sound business principles and operate profitably in the best interest of the shareholders.

The Alberta Stock Savings Plan encourages the provision of equity capital for new and growing Alberta companies. It entitles investors to a credit against Alberta tax payable, based on the purchase of eligible shares listed on the Alberta Stock Exchange.

Alta-Can Telecommunications Inc., a subsidiary of Alberta Government Telephones invests in private sector ventures in microelectronics and telecommunications. The company offers assistance in manufacturing goods with international marketing potential.

Alberta Opportunity Company is a crown corporation which provides financial and management assistance to stimulate the establishment of new businesses, and which assists in the expansion of existing enterprises. Financing is in the form of loans or guarantees of loans of other lenders. The loans are repayable with interest.

The Small Business Equity Corporation Program, a joint venture between the governments of Canada and Alberta, is designed to stimulate the formation of privately organized and managed pools of equity to provide Alberta small businesses with access to new and larger sources of equity capital. The government of Alberta does not directly provide investment capital for small business but rather it gives a 30 percent incentive to the private sector to invest in small business.

SPURT Investment Fund I is a joint private/public sector initiative, which provides equity investments in seed and early-stage technology enterprises and which participates in joint ventures in the fields of electronics and telecommunications.

The Small Business Term Assistance Plan offers fixed-rate loans for up to a ten-year term to shield businesses from fluctuating interest rates and allows for stabilized long-range financial planning.

The Business Immigration Program is a joint venture between the provincial and federal governments through which immigration status is granted to business immigrants who invest in job-generating businesses in Canada.

There are also federal programs that offer assistance to high technology businesses. These programs include the Industrial

Research Assistance Program and Industrial Research and Development agreements (jointly with Alberta) under the Economic and Regional Development Agreements.

In addition to support from the provincial and federal governments through these and other programs, direct financial support has also been given in a number of cases to various companies. This often involves the purchase of preferred shares but may also involve loans or loan guarantees. Finally, the Alberta Research Council has participated with companies in a number of joint venture research projects.

6.0 SURVEY RESULTS - THE LABOUR MARKET IN ADVANCED TECHNOLOGIES

6.1 Overall Survey Results

A total of seventy-three (73) interviews were completed, 31 in Edmonton, 37 in Calgary and 5 via telephone to other locations in Alberta (see Exhibit 6.1). The Edmonton total is for the metropolitan area as a whole and includes firms from St. Albert, Sherwood Park and Nisku.

Exhibit 6.1 also shows the sampling by industry. As discussed in Chapter 2, the sampling procedure was deliberately biased against the electronics industry because of the recently completed EIAA survey and toward product-oriented rather than service-oriented firms. Energy is also undersurveyed because considerable evidence is already available on human resource capabilities and requirements of this sector. As a consequence, care must be exercised when extrapolating the survey results to an advanced technology field as a whole. Nor will the survey methodology permit an estimation of the total size of the industry either in the number of firms or people employed. The primary purpose of the study was to provide some useful evidence of the concerns and expectations in each advanced technology field. Thesurvey accomplishes this and is able to demonstrate considerable consistency across the fields surveyed.

Exhibit 6.2 shows the stage of development for the firms. Products and the companies that produce them typically go through a life cycle of inception, prototype testing, growth, maturity and decline. The number of employees is usually very small at the inception stage, increases marginally during the testing phase then rapidly during the growth stage, before levelling off through the

EXHIBIT 6.1

COMPLETED INTERVIEWS BY INDUSTRY AND CITY

	Edmonton	Calgary	Other Alberta	Total
Advanced Materials	2	1	1	
Advanced Manufacturing	5	8	2	
Transportation	-	1	-	
Advanced Manufacturing Subtotal	7	10	3	20
Biotechnology	7	2	-	9
Electronics	2	3	-	5
Computer Systems and Software	6	13	2	21
Telecommunications	2	4	-	6
Medical	2	1	-	
Energy	3	2	-	
Photonics	2	2	-	
Other Subtotal	7	5	-	12
TOTAL	31	37	5	73

EXHIBIT 6.2

STAGE OF DEVELOPMENT FOR ALBERTA ADVANCED TECHNOLOGY FIRMS

	Inception	Prototype Testing	Growth	Maturity	Total
Edmonton	2	5	9	15	31
Calgary	-	8	11	18	37
Other	-	-	2	3	5
TOTAL	2	13	22	36	73

mature stage. Companies can extend their own life cycle by introducing new products before existing ones reach the decline stage. As Grubb and Ellis indicated, different sized firms at different stages in their life cycle will have dramatically different priorities and decision criteria. Therefore knowing a firm's stage of development is very useful for understanding the firm's resource requirements in the near future.

Biotechnology might be labelled the youngest industry as it includes the two firms at the inception stage and several at the prototype testing stage. Also, because Edmonton is the home of most biotechnology firms, it has a younger profile in terms of stages of development. (One note is that several firms chose to look at this question on a product by product basis, indicating that while some products were at the mature stage, others were being tested or were in the initial growth phase. In this case, the firm as a whole was considered mature.)

The distribution of firm size in terms of sales revenue is shown in Exhibit 6.3. Note that many of the firms in the sample are small with less than $5 million in sales revenue and that Calgary has a higher proportion of larger firms. It is also worth noting that the firms located elsewhere in Alberta are small and in the growth or maturity stages of development.

The average age of the biotechnology firms is 12.67 years while the median firm began in 1980. In 78% of the cases, the key decision-makers resided in Alberta prior to the establishment of their particular firm and only 19% of these people considered locating elsewhere. These results were consistent across the province.

Given these results, it was not surprising that familiarity with the area was by far the key factor for siting the firm in Alberta

(Exhibit 6.4). It was mentioned by 60% of the respondents. Proximity to supplier and customer markets (particularly the latter) (37%) and quality of life factors for employees (27%) were the only other factors to be identified by more than 20% of the respondents.

EXHIBIT 6.3

SIZE OF FIRM - SALES REVENUES

	$0-100,000	$100,000-1 m	$1 m-5 m	$5 m-10 m	$10 m-50 m	$50 m →	Total
Edmonton	6	11	7	2	3		29
Calgary	3	12	11	1	8	1	36
Other	1	2	2				5
Not Reported							3
TOTAL	10	25	20	3	11	1	73

Exhibit 6.5 gives a second measure of the size of the firms - total employment. These seventy-three firms employed 2954 people. As the exhibit shows, the median of these firm is only 12 employees while the average is just over 40 employees per firm.

If these result were extrapolated to give an employment figure for the 733 advanced technology firms identified by Alberta Technology, Research and Telecommunications, it would project up to 29,500 people. However we suggest that this estimate is upwardly biased because we would expect product-oriented firms to have a larger average size than service firms. Thus the results of this study are consistent with ATRT's estimates.

EXHIBIT 6.4

KEY FACTORS FOR SITING THE OPERATION IN ALBERTA

Possible Factors	Number of Respondents
Familiarity with area	44
- -	
Proximity to supplier and customer markets	27
Quality of life factors for employees	20
- -	
Ability to expand	14
Proximity to quality university	14
Affordable land, rent and building costs	14
Ample supply of qualified scientific and management staff	14
Supportive community encouraging entrepreneurship	13
Accessibiity to investors	12
- -	
Favourable tax levels/incentives	10
Low-cost potential workforce with minimal labour problems	10
Efficient transportation network	9

EXHIBIT 6.5

SIZE DISTRIBUTION OF SAMPLED FIRMS
BY NUMBER OF EMPLOYEES

Number of Employees	Number	%	
1 - 5	20	28	
6 - 10	15	21	
11 - 20	11	15	Average: 40.47 employees per firm
21 - 50	11	15	
51 - 100	10	13	Median: 12 employees/firm
101 - 500	5	7	
501+	1	1	
	73	100	

However these results cannot be used as confirmation of ATRT's estimates because they are based on the same population of firms. The more basic problem of what constitutes an advanced technology firm or field remains unresolved.

Production staff account for only 38% of employment (Exhibit 6.6) although this figure should not be surprising given the number of firms at the inception and prototype testing stages. The proportion of production workers could increase sharply if some of the firms are able to establish significant markets and begin mass production.

Exhibit 6.6 also shows that number of employees who were recruited from elsewhere in Canada and from outside of Canada. However these results have to be interpreted with some caution because a single firm accounts for 254 or 70 percent of the people brought to Alberta.

EXHIBIT 6.6

EMPLOYMENT IN SURVEYED FIRMS BY JOB TYPE

	Employees	%	Recruited From Elsewhere in Canada	Recruited From Outside of Canada
Managers, entrepreneurs	329	11	81 (26%)	13 (4%)
Scientists, engineers, researchers	356	12	109 (31%)	10 (3%)
Technicians (research)	405	14	47 (12%)	5 (1%)
Production personnel	1,142	38	62 (6%)	6 (1%)
Marketing personnel	240	8	38 (16%)	0
Administrative support staff	403	14	N/A	N/A
Other	79	3	N/A	N/A
TOTAL	2,954	100	337 (11%)	34 (1%)
	40.47 employees per firm			

As can be seen from Exhibit 6.7, while most of the firms did most of their hiring in Alberta, some companies had to look elsewhere in Canada and even outside Canada for all job types. Of the sixty-five firms that recruited staff from Alberta, 32 (or 49%) also recruited over a broader geographic area. The particular skills

that were not available in Alberta are discussed in the industry specific sections that follow.

EXHIBIT 6.7

NUMBER OF FIRMS RECRUITING BY REGION BY JOB TYPE

	Within Alberta	Elsewhere in Canada	Outside Canada
Managers, Entrepreneurs	60	17	8
Scientists, Engineers, Researchers	39	14	7
Technicians (Research)	47	8	2
Production Personnel	36	4	2
Marketing Personnel	31	5	4

Total employment in 1986 in the sampled firms was 2,617 people, indicating a 10% growth in the last two years; however this growth statistic hides the wide range of success over the time period (Exhibit 6.8).

Sixty-nine of the firms were willing to project their employment two years hence to 1990. Total employment in these firms is expected to rise to 3,994 people, an average growth of 43% in the average size of responding firms. Their optimism is reflected in range of growth rates in Exhibit 6.8 - no respondent foresaw their firm declining in size even though 26% had done so in the previous two years.

EXHIBIT 6.8

STABILITY AND PROJECTED GROWTH RATES
OF ADVANCED TECHNOLOGY FIRMS

Number of Employees	1986-1988	Projected 1988-1990	Projected 1988-1992
Decrease by 50+	3	0	0
Decrease by 21-50	1	0	0
Decrease by 11-20	2	0	0
Decrease by 6-10	4	0	0
Decrease by 1-5	9	0	0
Remain Constant	19	9	27
Increase by 1-5	21	17	9
Increase by 6-10	5	10	7
Increase by 11-20	3	14	3
Increase by 21-50	4	9	6
Increase by 51-100	2	7	2
Increase 100+		3	3
TOTAL	73	69	57

While most respondents were willing to project employment levels in 1990, a high proportion were not comfortable forecasting four years ahead. Fifteen respondents declined to give figures while another 38% forecasted no change from 1990 to 1992 (many of these had predicted a large increase between 1988 and 1990). As a result projected employment was 3,961 for the fifty-eight firms or

68.4 employees per firm. This represents an average growth rate of 18% over 1990-1992 in average firm size.

The survey provided some interesting results in terms of academic attainment of current employees and minimal field experience required for new hires (Exhibit 6.9).

EXHIBIT 6.9

EVIDENCE OF ACADEMIC ATTAINMENT

	Total Number of Employees	Diploma	Bachelor	Masters	PhD	Total with Diplomas/ Degrees
Manager/ Entre- preneurs*	329	69 (23%)	92 (33%)	21 (7%)	15 (5%)	197 (69%)
Scientist /Engineers /Researchers*	356	35 (10%)	237 (67%)	30 (8%)	42 (12%)	344 (97%)
Technicians	405	240 65%	43 (12%)	5 (1%)	0	288 (78%)
Marketing Personnel*	240	41 (21%)	55 (28%)	7 (4%)	0	103 (53%)

* One firm did not have the information available on their 32 managers, 35 technicians and 44 marketers. The percentages reflect the downsizing of the survey employment to allow for this missing data.

Sixty-six percent of the managerial-entrepreneurial class of employees have a post-secondary degree with 23% having a diploma from a technical institute. This relatively high proportion shows the applied nature of the work in these industries. Also note that fully 97% of the scientist-researcher-engineer category had a degree.

Many respondents declined to specify minimal field experience requirements because its company policy is to promote internally. Also several others said that experience and academic preparation are irrelevant - it is the person's ability to think that is important. However those respondents that do have minimal requirements typically preferred their managers to have either 5 or 10 years experience and their marketers to have at least 5 years (Exhibit 6.10).

EXHIBIT 6.10

DISTRIBUTION OF MINIMAL FIELD EXPERIENCE REQUIRED OF NEW EMPLOYEES

	Years of Experience					
	Zero or not stated	**1-4**	**5**	**10**	**10+**	**Total**
Manager, Entrepreneurs	30	12	18	9	4	73
Scientist, Engineers, Researchers	46	17	9	0	1	73
Technicians	40	30	2	0	1	73
Marketing Personnel	38	17	16	1	1	73

Finally 27 firms (37% of responding firms) had previously participated in co-operative education programs while 49 (or 75% of the respondents on this question) expressed an interest in participating in such a program.

The preceding discussion provides an overview of the labour force capabilities in Alberta's advanced technology industries. In the remainder of this chapter, information is presented on the individual industries.

Two general observations are worth making before the more detailed analysis is presented. First, most companies have identified very specialized market niches and therefore the future growth opportunities and human resource requirements tend to be very specialized, particularly in biotechnology and telecommunications. Second, many of the firms are distinctly 'low-tech' (i.e. using processes or equipment that is not state of the art) even though they are in a high-tech area. However, this may be the most cost effective alternative.

6.2 Advanced Materials and Manufacturing

Four advanced materials firms, fifteen advanced manufacturing and one transportation firm that manufactures all terrain vehicles were included in the survey.

This segment has a relatively older distribution of firms compared to other advanced technology areas as shown by the following table.

Decade Firm Incorporated

	30's	40's	50's	60's	70's	80's
Number of firms	2	0	1	4	9	4

As might be expected with this age distribution, the firms tend to be larger and more mature than other technologies. Eleven of the firms placed themselves in the mature category while another six were in their growth phase. There were no firms at the inception stage. Six of the firms had between $10 and $50 million in sales revenue and seven were between $1 and $10 million, although most were closer to the lower end of this range. The remaining seven firms were smaller.

Total employment for the 20 firms was 919 people, an average of 46 per firm. Eighteen of the firms were able to estimate their expected number of employees in 1990 and the total of these estimates was 1,334. This implies a growth rate of 84% over the two years (after adjusting the 1988 estimate for the two firms not included in the 1990 estimate); however a large part of this growth was due to one firm of 20 people which expected to have 300 on the payroll in 1990.

The sample of advanced materials and manufacturing did not include any firms using robotics or lasers in their processes and as such may understate the technological expertise. However Alberta has only an embryonic advanced materials/manufacturing industry and the fact that there are only one PhD and five masters degrees held by either the managers/entrepreneurs or scientists/researchers reflects the hands-on, adaptive orientation of the sampled firms.

The advanced materials and advanced manufacturing firms generally saw their competitive advantages either in terms of technological expertise and experience, or after-sales service. Several firms also saw their ability to make decisions quickly and customize their products to fit their customers' needs as critical. Other comments included low cost manufacturing, the ability to

constantly improve their product, testing capabilities, being a world-leader in thermo-electricity and being the only pipe-inspection shop in the world operating as a turn-key system.

Most of the companies are in Alberta because their major clients, the oil and gas companies, are here but some remained because the key decision-makers were here and never considered locating elsewhere.

The advanced materials firms required oil patch, chemical or industrialized rubber experience for their scientists/engineers/researchers group whereas manufacturing firms required more specific experience: aviation, mechanical engineering with aircraft instruments, control and safety equipment, down-hole testing, and heavy equipment vehicle manufacturing, as well as practical design capabilities. The managers were required to have sound technical capabilities, financing skills and product and business development expertise.

The companies have had to go outside Alberta to recruit the following:

- o chemists with rubber compounding experience;
- o manufacturing experience;
- o electro-magnetic experience in testing;
- o industrial design, specialized casting; and
- o engineers and mechanics in the aviation industry.

Responses on expected growth areas were also varied and were usually closely tied to a firm's own area of expertise:

- o computer design;
- o gas detection equipment;

- o rotary winged helicopters;
- o programmable logic controllers;
- o microprocessor based control systems;
- o computer systems design;
- o waste heat recovery, cogeneration;
- o electronic analyzers;
- o finite element analysis;
- o instrumentation of ultrasonic equipment;
- o computer-aided manufacturing; and
- o mobile radio telephones.

The required human resource requirements over the next three years however fell into much more traditional categories:

<u>Managers</u>

- accounting
- marketing
- good business sense
- manufacturing experience

<u>Scientists/Engineers</u>

- electronics
- computers
- mechanical and electrical engineering
- design skills
- manufacturing experience

<u>Technicians</u>

- electronics
- hands-on experience
- mechanical background

Many saw a critical shortage of manufacturing experience at all levels but especially machinists, tradesmen and production staff as Alberta does not have the base manufacturing industry and its associated skilled labour force.

Upgrading requirements had three major thrusts: technological expertise, computers (especially microprocessors and CAD) and general management and marketing skills.

Generally respondents in advanced materials and advanced manufacturing felt that educational programs at Alberta institutions were particularly helpful, specifically:

U of A

- electrical
- computers and mechanical engineering

U of C

- computers
- mechanical engineering

SAIT

- aviation
- instrumentation
- industrial electronics
- non-destructive testing
- mechanical manufacturing

NAIT

- non-destructive testing
- instrumentation
- industrial electronics

- mechanical engineers
- metallurgical and welding technologists

<u>Mount Royal College</u>

- instrumentation night courses

<u>Banff School of Management</u>

- management

Interviewee recommendations for improvement focused on gaining more hands-on experience. For example, there are almost no opportunities for students in university engineering programs to develop any welding skills. Hands on computer experience was the most frequently requested skill . The University of Waterloo was cited several times for the quality of its cooperative program.

A second comment made by several people was the need to educate students at the high school, college, institute and university levels in terms of work ethics, attitudes and the need to be profit-conscious.

6.3 Biotechnology

Biotechnology is the newest industry to be developed in Alberta, with 7 of the 9 firms interviewed having been formed since 1985. Two firms are at the inception stage, 3 are doing prototype testing and 4 are at the growth stage. Current employment of the firms sampled is only 218 people (or an average of 24 people/firm) but growth of 70% is expected in the next two years. Biotechnology has the highest concentration of postgraduate degrees with 13 PhD's in the management category and 38 in the scientific/engineers/researcher classification. This concentration is not surprising in that several of the firms were created as spinoffs from the universities.

It also had the highest proportion of firms who recruited from outside of Alberta. In total the biotechnology firms recruited seven managers; fourteen scientists, seven research technicians and three production staff from elsewhere in Canada. They also recruited one manager, five scientists and one technician from outside of Canada. These represent more than four employees per firm or about 17% of their staff.

The competitive advantages of the firms vary as they are each in a specialized niche within the biotechnology field. Five firms believe their advantage is their unique technology and that they are often in an area without significant competition. One firm's advantage is the large funding support provided by multi-national companies outside Canada while another uses the ARC to avoid high start-up costs and has obtained an exemption from FDA regulations.

Four of the firms are located in Alberta because their principals were from the province. The funding and loan guarantees available from the provincial government are major attractions for five of the firms. In several cases, the firms grew out of research being undertaken at the University of Alberta.

While the primary requirement for the management level of the company is business experience, the requirements for scientists and technicians are diverse and specific:

<u>Scientists</u>

- immunologists;
- academic training in organic chemistry, pharmacology, immunology and virology;
- peptide protein engineering;
- biological research in monoclonal antibodies;

- microbiology/parasitology experience; and
- chemical or process engineers with a willingness to learn.

Technicians
- high pressure instrumentation;
- lab experience in immunology techniques and research;
- biological research in monoclonal antibody production;
- chemical engineering or biology; and
- training in organic chemistry, pharmacology, immunology and virology.

Few of these skills have been available in Alberta and examples of where the companies went outside the province recently include:

- o process engineers/managers with good work ethics and proven team players;

- o managers and highly experienced scientists in the biology field;

- o PhD's with relevant experience in peptide and protein engineering;

- o biotechnology experience in immunology;

- o PhD's or senior scientists with carbohydrate cell surface skills; and

- o senior fermentation technology (only 10 in Alberta and 8 work at the ARC).

Biotechnology is seen as a growth area in general and each firm saw excellent growth potential in its field. This growth will generate demand for a variety of human resource areas:

- managers with experience in private sector agriculture;

- scientists with qualifications in genetic engineering, crop development and microbiology systems;

- fermentation and biochemical senior scientists;

- carbohydrate and biology PhD's with business and communications skills;

- technicians and production personnel with knowledge of biological and chemical production techniques;

- PhD/scientists in organic chemistry;

- molecular genetics, microbiology and immunology, clinical technicians;

- medical directors in biotechnical field; and

- combination of mechanical and instrumentation technicians.

The critical upgrading requirement is to enhance awareness of business management techniques.

Generally the U of A and U of C in organic chemistry, biochemistry, microbiology and genetics as well as NAIT and SAIT for biotechnical training programs received very positive feedback. However the latter two programs are new and have yet to establish a track record.

More hands-on experience is again required. One respondent believes the focus should be on Added Value Agricultural Products

in Plant Biotechnology programs. In his opinion, there is still a big gap between the universities and institutes' teaching, and industry needs.

The Universities of Waterloo, Guelph, British Columbia, Victoria, Manitoba and Saskatchewan were all said to produce excellent graduates; one respondent felt these were better than what was available from U of A or U of C.

In the survey respondents' opinions, biotechnology students in future will require more business training and an enhanced ability for independent thinking. Co-op programs at the University of Victoria were recommended as a role model. Several firms have tried co-op programs and have been satisfied with the results. However, not everyone was in support of the cooperative approach. Some believe the programs are too costly in both time and money and that the companies gain little benefit. Another respondent raised the coordination problems involved when the universities or institutes have to find placements for their students and schedule training classes.

Other comments of interest included:

- I have a concern with the cost-effectiveness of any scientific research in universities and within government ministries in Canada in general - there seems to be a belief that high tech is always good regardless of the <u>costs</u>. Most institutes are concerned with finding ways to "scale up" technologies for its own sake and do not look at the high cost associated with these technologies. They train students to think that way too, no one seems to be interested in low tech research (or research in finding ways to produce economically);

- Universities train students to follow the same research projects started 20 years ago; no initiative is shown on the student's part to design his/her own research programs; professors do not want to take risks of doing new projects and possibly losing research grants so they just use grads to do research for them as cheap labour. A remedy for this would be to review grants

every five years on the condition that they start a new project, with the exception of the top 20% of researchers who have potential for breakthrough discoveries. This would eliminate the attitude of regenerating old research year after year;

- o Manpower is not the problem. Money is. The Alberta Heritage Fund is good but not known outside Alberta and it is not applicable to operations, only construction. Decision-makers do not know enough about biotechnology to make intelligent decisions on how to distribute the funds. Biotechnology firms need at least 4-5 years of operating funds to get to a viable product stage. There is not a biotechnology industry in Alberta. Government needs to develop the industry first and then consider human resource training. I would probably leave Alberta if moving costs were not too high. There is no advantage to staying in Alberta and it is difficult to attract good people here; and

- o A one-stop reference centre for Canadian high-tech material would be useful, including -

  a) trade journals indicating new technologies used in Canada,

  b) an inventory of equipment in government departments or government sponsored labs that has time available for rent, including availability and cost of rental.

6.4 Computer Systems and Software

The computing systems and software industry for the purposes of this report are those segments of the industry that market specific products as opposed to just offering services. While eliminating the data processing firms, this definition also excludes many of the firms that provide sophisticated support services for the petroleum and other sectors. In a 1985 survey of the software industry in Alberta prepared for Alberta Economic Development and Trade, the industry was described as follows:

- o About 300 firms participated or had direct involvement in software development and production.

- o The total revenues generated directly from software product sales of these firms was estimated between $45 to $81 million. Processing services accounted for between $44 to $73 million and professional services for between $78 to $114 million.

- o The firms surveyed represent approximately 884 persons employed in software development out of a total of 4,637 employees, or about 19 per cent of the total personnel.

- o It was estimated that in 1985, some 1,300 Albertans were involved directly or indirectly in the software development industry.

- o 63 per cent of the firms surveyed operate with less than seven employees, while about 37 per cent operate with one to three employees.

- o In 1985, the average firm produced revenue from software products alone between $150,000 to $270,000 within Alberta.

- o The surveyed firms were predominantly young with over 45 per cent of the firms less than five years old.

- o 54 per cent of the firms were Calgary based, 39 per cent Edmonton based, and 7 per cent were based in other centres.

- o Business-based software was by far the most common product, followed by system software and scientific and engineering software.

The firms sampled in this advanced technology survey had a younger age distribution than advanced materials and manufacturing (this is consistent with the previous survey) yet had a much

higher proportion of mature firms. Most of the companies had a single product, and computer software tends to reach maturity in terms of sales revenues more quickly than most products. The 21 companies sampled had an average size of 31.33 people for a total of 658 employees.

	50's	60's	70's	80's	TOTAL
Age Distribution by Decade	1	1	8	11	21

	Inception	Prototype Testing	Growth	Maturity	Not Stated
Stage of Development	0	2	4	14	1

Twenty of the firms were willing to estimate the number of people they expect on the payroll in 1990 and these firms expect to grow from 21.2 people per firm to 30.6, a growth rate of 44%.

In terms of academic qualifications, the computer industry is fairly typical of advanced technologies as a whole with 2 PhD and 10 Masters degrees amongst the managers/entrepreneurs and the scientist/researcher groups that were interviewed.

This group of companies also exhibited the most internal consistency of the advanced technologies studied. Experience, motivated staff, established reputation and proven software development skills were the keys to developing a competitive advantage in this industry. Several firms also mentioned the importance of size, a broad national base and financial support as critical to withstanding market shifts.

Consistent with the overall results of why firms located in Alberta, 35% of the firms studied indicated it was because the key decision-makers already lived in Alberta, 25% are here to be close to their customers and 20% for quality of life reasons. These factors clearly dominated the locational decision.

Necessary relevant experience required for new employees was defined along fairly traditional lines:

Managers

- business experience (finance, marketing)
- knowledge of computer industry
- knowledge of client industries
- attitude, flexibility, leadership
- people skills
- entrepreneurial skills

Scientists/Engineers/Researchers

- technical background in both hardware and software
- systems engineering
- people skills
- knowledge of client industries, particularly oil and gas
- design skills
- hands-on experience

Technicians

- computer aptitude
- knowledge of hardware
- technical ability

The firms have gone outside Alberta relatively infrequently - primarily for marketing skills (3 responses).

The respondents also were more in agreement on the future growth areas than other industries. Networking, microcomputers, office automation and desk-top publishing all received consideration. Customized software development, particularly for the oil and gas industry was also identified as a growth area. Specific examples pinpointed for their growth potential include satellite surveying, 3-dimensional geophysical programs and land related information systems.

The critical skills needed in the next three years involved programmers with state-of-the-art skills, marketing (both domestic and international), good written communication skills and managers with good interpersonal skills.

As a result, upgrading and retraining efforts are concentrated on keeping abreast of current technological improvements, management training, communication skills and project management.

Most people found the computer programs at U of A, U of C, NAIT and SAIT to be useful, although several people were clearly disappointed with the quality of the programs. Over half of the respondents noted the need for more hands-on experience, particularly at the university level. Two people suggested that this experience could be obtained by an apprenticeship-type program. Finally, a common concern by most respondents was the need for the educational institutions to ensure their programs and equipment are up-to-date.

The companies have gone outside Alberta for company-supplied training on specific applications and for co-op programs at the University of Waterloo, CGEP in Quebec, Algonquin College in Ottawa and the University of New Brunswick. They would like Alberta institutions to add practicums, cooperative programs, more

university-business exchange and technical writing programs. Those that have participated in cooperative programs had mixed success and commented on the time requirements but were generally in favour of more cooperative programs.

6.5 Electronics

As was discussed earlier, the electrical industry was deliberately undersampled because the Electrical Industry Association of Alberta had just completed a major survey of its members. Five interviews were completed as part of this study to ensure that responses to the more qualitative questions were consistent with responses from other advanced technology areas. All five firms interviewed were very small with less than 10 employees. Four had been formed since 1980 and four had sales revenues of $100,000 to $1,000,000. Unfortunately, this is not representative of the structure of the industry as a whole. The following provides information drawn from the EIAA survey to provide a better understanding of the electronics industry in Alberta.

As discussed in Chapter 2, the EIAA was able to secure usable responses from 101 firms out of their population of 120 firms. In terms of size, the survey respondents had the following distribution with a median size of 10 employees.

Employees							
1-5	6-10	11-20	21-50	51-100	101-600	600+	Total
31	22	18	17	7	4	2	101

In terms of age, 31 companies were formed in the last five years, 29 are six to ten years old and 31 are more than eleven years old. (Data was not available on 10 firms.) The median age is eight years.

In each of the last 3 years (to 1986), between 28% and 31% of the firms have grown by more than 25% in the year. However, between 11% and 17% have incurred losses in each of those years. There was no correlation between growth rates and the size of the firm.

Few firms foresaw losses in the next three years, 35% each year expected to grow by more than 25% in the year while 45% in each year expected more modest growth rates of between 6% and 15% per year.

In general, the firms rated themselves as very strong in technical and engineering skills while manufacturing and project management rated strong ratings. International marketing, domestic marketing and finance required strengthening while the firms saw themselves as adequate in accounting (few saw themselves as either more than or less than adequate) and human resource management (but some saw the need for strengthening). The last two results are typical of firms that consider accounting and human resource management as support functions.

Exhibit 6.11 indicates the type of research and development done by the electronics firms. There is a strong emphasis on product development and product improvement.

In terms of markets, Exhibit 6.12 shows the number of firms that service the various sectors. While the majority of firms work with the petroleum industry as expected, there is considerable diversity in terms of other markets. The computer software firms have clearly identified market niches for their products.

EXHIBIT 6.11

RESEARCH AND DEVELOPMENT FOR ELECTRONICS FIRMS

Type of R and D	% of Respondents
None	5
Basic Research	13
New Product Development	83
Process Improvement	30
Product Improvement	69
Quality Control	23
Technical Development	37

EXHIBIT 6.12

TARGET MARKETS FOR ELECTRONICS FIRMS' PRODUCTS

Sector	No. of Firms
Petroleum	53
Agriculture	27
Telecommunications	25
Defense	22
Transportation	21
Mining	21
Computers	19
Forestry	17

The 101 firms show healthy growth expectations (especially considering the median firm size is 10 employees) as shown by the Exhibit 6.13. Particularly strong demand is expected for university graduates, technologists, and technicians in the electronics areas. Demand was also strong for generalists and functional specialists in the business areas.

EXHIBIT 6.13

EXPECTED NUMBER OF INDIVIDUALS TO BE HIRED

(as of 1986)

	1987	1989	1991
Electronic/Electrical Areas			
PhD's	5	8	12
Masters	14	17	23
Bachelors	100	101	158
Technologists	94	164	177
Technicians	69	90	111
Business Areas			
Generalists (Strategists, Managers, Entrepreneurs)	26	49	44
Specialists (Accounting, Admin., Marketing)	53	74	69
Physics/Science Graduates	21	15	24
Other	9	11	14

A different pattern emerges when considering areas of specialization (Exhibit 6.14). Here electronics manufacturing clearly dominates with strong demand for electronics design, basic electronics, VSLI designs and software design.

The survey also provided extensive information on the types of training required. Exhibit 6.15 identifies the number of firms sending employees for training by type of employee and type of training. These were the major categories out of 21 possibilities. What is important to note is that more than one third of the firms identified the need for improved presentation skills.

EXHIBIT 6.14
NEW HIRES BY AREAS OF SPECIALIZATION
(as of 1986)

	1987	1989	1991
VLSI Design	37	48	43
Fiber Optics	1	6	7
Electronics Manufacturing	73	167	153
Satellite Communication	2	10	10
Electronics Design	44	50	50
Computers and Peripherals	8	15	24
Basic Electronics	25	36	34
CAD	12	16	17
MPU Design	15	21	19
Software Design	34	58	56

EXHIBIT 6.15
TRAINING REQUIREMENTS BY TYPE OF EMPLOYEE

Course Area	Employee						
	Engineers	Technologists	Technicians	Bus. Mgrs.	Unskilled	Other	Total
Presentation	12	6	3	8	-	8	37
Electrical Manufacturing	10	9	8	5	7	0	39
Circuit Design	11	11	3	-	-	1	26
CAD	9	12	1	-	-	2	24
Basic Marketing	6	4	-	7	-	2	19
MPU Application	9	9	1	-	-	1	20
Project Management	7	1	-	6	-	-	14
International Marketing	2	-	-	7	-	9	18

The firms were also asked to identify the numbers of people they would send for training. Exhibit 6.16 shows that while almost as many respondents saw the need for presentations training as those who identified electrical manufacturing, more than twice as many staff require training in the latter as compared to presentations. The change in ranking also reflects the different sizes of firms in the various areas of specialization.

EXHIBIT 6.16

NUMBER OF PEOPLE TO BE TRAINED

Course Area	Number of Employees						
	Engineers	Technologists	Technicians	Bus. Mgrs.	Unskilled	Other	Total
Electrical Manufacturing	13	70	76	5	92	-	256
Presentation	35	23	15	11	-	8	92
VLSI	41	8	2	-	-	-	51
Software Design	3	8	1	-	-	25	37
CAD	11	17	1	-	-	2	31
MPU Design	11	11	1	-	-	1	24
Satellite Communications	12	-	18	-	-	-	30
Project Management	9	1	-	10	-	-	20
Basic Marketing	8	5	-	9	-	7	29
International Marketing	3	8	1	-	-	25	37

The survey also presented some interesting insights into areas the respondents felt that new graduates required further training (Exhibit 6.17). It is very interesting that these process skills were the dominant categories out of 20 possible choices that included analog electronics, digital electronics, general engineering, mathematics, marketing, finance, accounting and government relations.

EXHIBIT 6.17

TRAINING REQUIRED BY NEW GRADUATES

	Engineering Graduates	Techno-logists	Techni-cians	Bus. Mgrs.	Others	Total
Practical Issues	33	20	14	8	22	97
Attitudes	22	19	14	12	32	99
Written Communica-tion	22	26	13	8	28	97
Oral Communic-ation	20	22	9	7	19	77
Presentations	15	13	9	6	17	60

Exhibit 6.18 shows how the respondents ranked government initiatives that would be the most helpful/important to their business, (1 - most helpful; 5 - least helpful). Note that while increased availability of skilled labour was important, it ranked behind all five of the financial incentives. The exhibit also shows the importance the respondents give to improving their marketing skills and capabilities.

EXHIBIT 6.18
GOVERNMENT INCENTIVES

	Rank 1	Rank 2	Rank 3
Increased availability of skilled labour	16	4	21
Increased availability of risk capital	39	11	17
Greater tax incentives to support R&D	41	16	16
Greater government funding to support R&D	40	19	9
Greater government support for product development	41	15	16
Greater government support for marketing and promotion	27	17	22
Easier access to foreign markets	17	12	28
Increased copyright protection	9	8	20
Expanded opportunities to work with universities on R&D	2	8	21
Access to facilities for product testing/evaluation	11	11	29

Finally, the respondents were also asked for suggestions on how educational institutions could produce better equipped graduates. Their open-ended answers are summarized in Exhibit 6.19 together with the frequency of the comment. It is interesting to note that the comments of these EIAA respondents reflect similar concerns to those expressed in this advanced technology study.

EXHIBIT 6.19

SUGGESTIONS TO EDUCATIONAL INSTITUTIONS REGARDING BETTER PREPARED GRADUATES

	Frequency
More practical experience	10
More hands-on experience	5
More cooperative programs	4
More business training (including marketing)	7
Better work attitudes/work ethic	7
Better interpersonal skills	4
More institution/industry interaction	3

In terms of human resource improvement initiatives, one respondent commented that most human resource or support programs are not good value for the money; the key is to provide training subsidies to help ongoing operations. A second felt that co-op programs were good to expose students to the "real world" becaue they felt students required a minimum of two years of training in their industry before the individual makes a positive contribution to profits.

6.6 Telecommunications

Our advanced technology survey included six telecommunications firms, two at the prototype testing stage, three in the growth stage and one mature firm. This is a relatively new segment of the economy with 80% of the smaller firms (excluding the mature firm) having been established since 1983. Their competitive advantages range from expertise in Global Positions Systems

(GPS), unique market niches and unique potential products to an ability to generate ideas, excellent R&D, an ability to react quickly because of their small size relative to their competitors, a highly motivated staff and low cost manufacturing.

The future growth in the industry is anticipated in telephone terminals for the mass market, circuit mounts, custom IC (integrated circuit) fabrication, optical fibre FAX machines, applications in GPS and consumer TV receivers. The critical manpower requirements over the next three years include electronic design, R.F. (radio frequency) design, computer software development relating to supercomputers and ray tracing technologies, microwave engineering, and for low wage, highly dexterous people in production. International marketing personnel and scientists, engineers and technicians with electronics experience will also be needed.

The firms have already had to go outside the province for skilled people with expertise in large plastic injection molding, machining and tooling for large 3-dimensional machines, electronic design, RF circuit design, as well as people with knowledge of GPS surveying.

In the area of retraining, one firm encourages retraining or upgrading for all staff from managers to secretaries through company paid seminars and workshops. The company will also hold 2-3 major inhouse seminars each year on such topics as antenna technologies, digital systems processing and leadership. Others indicated needs in electromagnetic interfacing and software programs. The latter is being handled through on-the-job training. Lethbridge Community College is working closely with one firm to provide the training they require, either at the plant site or the college. Recent offerings have included soldering and RF testing.

In terms of educational programs, Westerra was found to produce good, well-rounded electronics and computer technicians. The U of C and University of New Brunswick were commended for their surveying with GPS programs. The co-op engineering programs at the U of A and Waterloo, and NAIT and SAIT programs in general also received recognition. The University of Victoria was commended for its co-op software program. Finally, the U of C was seen to have a proactive faculty doing strong research. Again, the primary criticism was that the university programs were too academic - typical comments were that they would choose SAIT graduates over university graduates, or they would like to see a co-op program at the U of C. There was also some concern that U of A's engineering program wasn't as good as 10 years ago, in part because of outdated equipment and large class sizes. One firm would like to see the students in engineering programs trained in C-language in computing science, not Basic or Fortran, while another would like all graduates to have more marketing skills and basic management (i.e. a practicum in time management, human relations and personnel management).

One firm recommended the Thunderbird Program at Phoenix, Arizona for an intensive workshop format that they feel goes further than the Banff School of Management's program.

In terms of recommended actions, the respondents in telecommunications suggested:

- a strong co-op program modelled after the University of Waterloo's program;
- a life skills course (and test) for grade 12 students;
- more mathematics in the early school years; and

o business input into the public school system.

6.7 Other (Medical, Energy, Photonics)

While medical, energy and photonics form a rather disparate collection of advanced technology fields, they are grouped here for practical reasons; the small sample representation of each does not warrant separate discussion. Distinctions will be drawn among the three industries where relevant. The following information characterizes the firms in terms of age, stage of development and sales revenue.

Decade of Incorporation

	60's	70's	80's
Medical		1	2
Energy	1	3	1
Photonics		1	3

Stage of Development

	Inception	Prototype Testing	Growth	Mature
Medical	-	1	-	2
Energy	-	-	1	4
Photonics	-	1	1	2

Size

	\$0-100,000	\$100,000-1m	\$1m-5m	\$5m-10m	\$10m-50m
Medical		2	1		
Energy	1	2	1	1	1
Photonics		2	1		

The average medical firm size was five employees and they expected to grow to an average of seven employees by 1990. The energy firms ranged in size from 1 to 250 employees and anticipated minimal growth. Finally the four photonics firms currently had 25 employees in total and expected this to grow to 43 by 1990.

The three medical firms all saw their competitive advantage as their unique products and innovative approach; while the energy-related firms emphasized their Canadian-wide markets and their commitment to service. On the other hand, two of the four photonics firms stressed their low-cost operation while the competitive advantage for the other two was the quality of their equipment.

The firms in all three industries are located in Alberta either because the principals lived here (6) or their clients are based here (4).

New managerial hires for the photonics firms will require good generalist skills while in the energy related firms the key skill for the managers, scientists and technicians will be their technical ability.

Only one energy firm has had to hire people from outside of Alberta and this was for waste management and technology experience.

Future growth areas for the three industries showed considerable commonality; computerization was mentioned in all three. Also identified were air pollution control devices, CO_2 and visible lasers, and microelectronics.

Critical skill areas identified included:

- o scientists/engineers with industrial design experience;
- o good journeymen electricians and other production personnel (in all 3 industries);
- o waste management technologists and waste management marketing;
- o optics and laser skills; and
- o technicians in the optics industry with good computer skills.

Respondents in all three industries saw the need for trades upgrading in such fields as machining and welding. Also mentioned were writing skills and personal development.

Courses from the community colleges on personal development, management, machining, packaging and fitting were all found to be quite useful while the evidence was mixed on the quality of trainees from the universities and technical institutes. Criticisms ranged from students' expectations being too high and no hands-on experience to poor work habits and attitudes.

More cooperative programs such as those at Memorial University in Newfoundland and the University of Waterloo were suggested as mechanisms to improve the Alberta course offerings as well as more electrical maintenance training in the electronics programs. It was also suggested that the Alberta Laser Institute organize laser optics services courses.

Two firms found apprenticeship programs were very valuable while one firm had a much less successful experience with cooperative programs in the late 1970s and has not participated since. The New Venture Program at U of C where business students assist in the preparation of marketing plans, etc., was also commended for the quality of its program.

Finally the subsidy programs are useful for the small firms but the paperwork must be kept to a minimum; one-half of a day is all the entrepreneur can afford for the hiring process.

7.0 ISSUES, RECOMMENDATIONS AND CONCLUSIONS

7.1 Issues and Recommendations

Innovation and new technologies are having a dramatic impact on national and regional economies throughout the world by changing the relative competitiveness of products and production processes. Regional economies such as Alberta's must diversify and develop its own high technology based industries or risk the possibility of stagnation and a decrease in the standard of living of its residents. This process of change is also being transmitted to the regional labour markets creating strong demands for new skills and making other skills obsolete. This constant adaptation means that life-long learning must become an important part of our culture. It also means that we must look for ways to increase the productivity of our labour force. The following issues have been identified and certain recommendations follow from them.

It is important to emphasize that these are the study consultant's recommendations, and are presented to Alberta Career Development and Employment and the other stakeholders for their consideration.

7.1.1 Cooperative Programs

The transformation to knowledge-based technologies is increasing the need for close cooperation between industry and our education system. Human resource policy studies and surveys of industry requirements all stress the importance of improving the students' preparation for entering the workforce. Usually more cooperative educational programs are recommended and the very successful program at the University of Waterloo is often identified as a good role model.

This survey of the human resource capabilities and expected future requirements of Alberta's advanced technologies is no different. The call for more cooperative programs was by far the most requested change and 75% of the respondents indicated a willingness to participate in such a venture. Most of the interest in the cooperative approach to education was focused on the Alberta universities. The post-secondary institutions have made some movement in this direction and away from the traditional approaches in recent years. Along with co-operative education programs, post-secondary institutions have also established programs with a work experience component. Few of these, however, are related to the advanced technologies. Despite these recent developments, industry would like to see much more accomplished. Respondents generally felt the technical institutes were doing a better job of preparing their students but then this is their direct mandate. However, the respondents saw room for improvement here as well.

A significant barrier to the development of new cooperative programs is they are more costly to deliver and require extra administrative resources to arrange placements and monitor progress. However, post-secondary institutions' budgets are currently restrained and it is difficult to introduce any costly new programs or approaches. Another barrier is that many educators, particularly at the university level, do not have industry experience and fail to appreciate the benefits of the cooperative education approach.

While the universities have been adapting, it has been at a slower rate than industry leaders would like to see and perhaps less than what is required to help industry remain competitive in the international markets. What is often not realized is the

commitment required of industry. The companies that do participate must also incur costs in terms of time, money and flexibility (i.e. a position must be kept open for the student). For smaller firms these administrative costs can more than offset the benefits of such a program, particularly when there is no guarantee the student will join the firm upon graduation. Also a large number of firms must be involved so that the university or institute does not have to utilize the same firms year after year.

In spite of the additional costs, most firms surveyed were interested in becoming involved in a cooperative program. We also believe that experiences with such programs clearly demonstrate that the benefits of better prepared graduates outweigh the costs.

<u>We therefore recommend the Alberta educational institutions, and the universities in particular, make a concerted effort to develop more cooperative programs.</u>

<u>We also recommend that the provincial government take a strong policy stand in support of cooperative education programs and provide additional funding specifically targetted to these programs.</u>

7.1.2 Apprenticeship-Like Programs

An alternative to cooperative education programs is an apprenticeship-like program for advanced technology areas such as microelectronics, biotechnology and computer software design. A defined series of learning experiences together with clearly established evaluation criteria could be developed by industry

and Alberta Career Development and Employment. The resulting programs need not include the legislative dimension of the current apprenticeship system.

This new type of program would have three advantages for industry over the cooperative education approach. First the employee gets academic preparation instead of the student gaining industry experience. The important distinction is that the learning experience is initiated and controlled by industry. Industry participants in the traditional cooperative educational programs may influence the direction and content of these programs through advisory councils and the like but the programs remain under the control of the educational institutions.

Second, the apprenticeship-like programs need no minimum size restriction. For example, if such a program was established for CAD (computer assisted design), it would probably involve training on the AUTOCAD system, the current industry leader. However, if a firm uses a different system such as PRIME, the AUTOCAD program would be of little use for their employees. It should be possible for the company to define a training program for its staff which might involve taking specific supplier delivered courses in eastern Canada or in the United States. If the individualized program was sufficiently rigorous and included a clearly defined evaluation process, it might then be eligible for funding support from ACDE under this proposed system. The possibility of individualized programs is very important for advanced technology firms because most occupy a specialized market niche and as a result their employees require specialized training and upgrading programs.

Third, Alberta already has one of the finest apprenticeship training programs in North America. The mechanisms are therefore already in place to ensure standards of quality are developed and maintained. The educational institutions would also have a role to play in the apprenticeship-like programs. If anticipated demand is sufficient, the institutions may wish to be involved in the design and delivery of the training program. We expect that the apprenticeship-like programs could be implemented faster than the university-provided cooperative programs because of the universities' internal approval systems. Nevertheless we see a role for each approach in Alberta.

We therefore recommend that ACDE encourage the development of apprenticeship-like programs in advanced technology areas.

7.1.3 Training and Management Institute

Small and medium sized research companies tend to be technology oriented rather than market driven. The entrepreneurs often face a major dilemma in determining how to successfully bring their products to the market. Thus a key concern of many of the interviewees was the development or upgrading of the management and marketing expertise in the company.

Many employers face a similar problem when considering training. Because they are often small with low profit margins, they cannot afford the monetary and time-lost costs of training. They also do not have the experience to properly conduct training needs assessments or know where to obtain information on available government training assistance. Within the provincial government for example, the interested firm might

contact the Small Business program, Alberta Economic Development and Trade, Alberta Technology, Research and Telecommunications or ACDE. They might also approach any one of the educational institutions. These same information needs have been identified in the major Canadian policy studies discussed in Chapter 3.

A Training and Management Institute for Advanced Technology could serve several functions:

- provide a focal point to increase an awareness of the need for life-long learning;
- provide training needs assessments and advice on training strategies;
- maintain an inventory of the training available for advanced technology firms at the universities, colleges, technical institutes and in the private sector;
- play a leading role in maintaining a communications network among trainers so that inquiries for assistance can quickly be directed to the appropriate responder;
- coordinate and facilitate management and marketing training for entrepreneurs; and
- conduct research on the changing human resource requirements of the advanced technologies.

To the extent that some of these functions are already being provided by the different government agencies, these functions could be transferred over to the Institute. For example, if some of the Training Consultants within ACDE specialize in the advanced technology areas, they would be candidates for the staff of the proposed Institute.

The Alberta Laser Institute and the Alberta Microelectronics Centre provide focal points for the emerging laser and microelectronics industries (or sub-industries). The proposed Institute would fulfil the same role in the human resource area and thus complement the technology-oriented research centres and institutes.

<u>We therefore recommend that Alberta Career Development and Employment give strong consideration to the establishment of a Training and Management Institute for Advanced Technology.</u>

7.1.4 Training Guarantees

Another reason for many managers of small firms not encouraging training for their employees is the potential loss of the employee after their skills have been upgraded through company-sponsored training. Larger firms that do a lot of training can rely on the law of averages; the cost of training people who subsequently leave the company will be offset by the gains contributed by the people who stay. They can also compensate for a worker who is on training by sharing the job responsibilities among several people. The smaller firms do not have these luxuries. Pulling an employee off the production line for an extended training period represents a signficant cost. If that cost cannot be subsequently recovered by productivity improvements or enhanced responsibilities because the person resigned, the training represents an expensive lost investment for the firm.

ACDE could remove some of this down-side risk by providing training guarantees whereby the Department would compensate the firm for the out-of-pocket training costs incurred if an

employee leaves within a specified time period after completing the training program. If the employee stays with the firm, the firm benefits and is properly responsible for the training costs. The advantage for ACDE is that a guarantee program would be less expensive than a subsidy program in that the cost of training is subsidized only in those cases where the employee leaves the firm, not all training.

Thus we recommend that Alberta Career Development and Employment investigate the viability and likely effectiveness of a training guarantee program to stimulate more human resource upgrading by companies.

7.1.5 Technical Research Assistance Program

One way of stimulating the introduction of new technologies could be to subsidize the hiring of new technicians, engineers and scientists for a certain period of time. For such a program to be effective, ACDE would have to have some assurance that the employment represented real growth for the company rather than simply replacing departed staff. Restrictions might also be added to ensure that the new employee was indeed working on advanced technology applications. Again it is the smaller and medium sized firms who will have the most difficulty financing expansion and any technical research assistance program should be targetted to these firms. In Ontario, the government has such a program for companies with less than $100 million in sales revenue but Alberta may wish to consider a lower limit given the smaller size of Alberta's advanced technology companies.

We believe that this idea has considerable merit as a mechanism to improve Alberta's technological base in the advanced technologies and recommend that ACDE investigate the potential of such a program.

7.1.6 Increased Awareness of Industry in the School Systems

The previous recommendations have all focused on post secondary students or people that are currently employed. Several interviewees in this advanced technology survey stressed that efforts to improve students' awareness of industry opportunities in the future and the skills and attitudes necessary to take advantage of these opportunities must be done at an earlier stage in the education process. This reiterates what has been emphasized in the policy papers such as The Report of the National Technology Policy Roundtable.

Several years ago in Calgary there was a very successful "Industry Expo" targetted primarily to Grade Nine students. An awareness of and interest in the business world could also be stimulated by a program for high school students with lectures by entrepreneurs and managers and plant visits. Alberta Education currently sponsors a small "Adopt a School Program" that has these objectives but we understand this matches one company to one school and a broader exposure might be worthwhile. Such a program could also increase the awareness by the students of the growing importance of mathematics and the sciences as keys to participating in the new technologies job market.

We recommend that the Research Development Authorities in Edmonton and Calgary or a similar municipal organization take the initiative for an annual Industry Expo or some other awareness program targetted to the high school students in their city and that ACDE consider financially underwriting some of the costs of the program.

7.1.7 Industry Purchased Training

One strategy that has been successful in other jurisdictions is for a firm or industry to financially underwrite part of the cost of a particular academic program where a large proportion of the graduates are hired by the firm or industry. For example, Pratt and Whitney is partially funding a program at the Nova Scotia Institute of Technology where they are hiring about 75% of its graduates of the particular program. In a similar vein, most firms do not recognize the willingness of many educational institutions to develop company-specific training programs on request. For example, Manitoba's Red River Community College recently signed a contract to train the employees of Canadian Bronze on automated lathes and mills. Closer to home, Lethbridge Community College has delivered several tailor-made courses for Novatel both at the College and at the plant site. Other examples exist throughout the province. An advantage of this approach is that it gives the companies more control over the design and delivery of the courses than does simply purchasing seats in existing courses.

Corporate human resource development managers, particularly in the medium and larger sized firms should explore with their local college, institute or university this possibility of having courses designed specifically to fulfill their requirements.

7.1.8 Transition Training

The universities have often been hesitant to provide much in the way of job entry training (how to write a resume, what to expect in an interview, the school-to-work transition, etc.) because it was not consistant with their academic mandate. The programs have also been generally lacking at the high school level. To some extent Alberta Career Centers fill this void but industry is finding that more needs to be done. One option is that Alberta Career Development and Employment sponsor such a program either as a practicum that is required for graduates or as a series of programs offered at the high schools or post secondary institutions on a voluntary basis. ACDE could also train the trainees for such programs.

We suggest that ACDE conduct a study on the availability of school-to-work transition type courses in terms of both content and location and determine whether there is an unmet need for such a program.

7.1.9 Strategic Procurement

The Alberta government is missing a significant opportunity to develop Alberta capabilities in key industries such as computer software design by not requiring work they contract out be done by Alberta-based firms. One of the difficulties in developing an advanced manufacturing industry here in Alberta is the lack of a skilled labour force in more traditional manufacturing. A similar problem affects other advanced technology areas as well. The Quebec government and Hydro Quebec used their purchasing power in the 1970's to help create three major engineering firms which now sell their services around the world. Manitoba, together with the City of

Winnipeg, Manitoba Hydro and Manitoba Telephone, are currently exploring the idea of pooling their resources to create a Manitoba-based land-related information systems capability. All have major LRIS requirements in the near future and if they all acted independently, an estimated $60 million of work would have gone outside the province. Pooling their procurement strategies creates the option of a home-grown capability. Similar opportunities exist in Alberta in several fields, particularly computer software. However, such a strategic procurement policy would require a change in current practice and may be inconsistent with the recently signed Free Trade Agreement.

<u>Nevertheless, strategic procurement represents a powerful policy to improve the human resource capabilities in the advanced technology fields in the province and we recommend that ACDE strongly consider taking a lead role in promoting its adoption as provincial government policy.</u>

7.1.10 Future Updating of the Advanced Technology Labour Force Assessment

As Alberta's advanced technologies grow, it will become increasingly important to remain apprised of their human resource requirements. If the Training and Management Institute for Advanced Technology is established, it would be in the best position to acquire and maintain this information as part of its research mandate. Updating the information would likely be most effective if it were done on a technology area by area basis. This would allow different areas to be updated each year and for the information to be gathered for both product and service oriented firms.

ATRT's CANTECH database provides the best information available on the advanced technology industries. Now that the database is operational, we suggest that serious consideration be given to culling the database of distinctly basic manufacturing firms in the advanced technology fields. Their inclusion overstates the population of firms of direct interest to the government decision-makers. More importantly, creating programs to respond to their basic manufacturing needs may seriously distort the policy initiatives away from the firms they were intended to assist. Nevertheless it is an excellent reference point and one responsibility of the Training and Management Institute could be to maintain the human resource component of the database.

We therefore recommend that the updating of the labour force assessment of the advanced technologies be part of the mandate for the Training and Management Institute for Advanced Technology. We further recommend the information be updated on an area by area basis over a three or four year cycle and that service-oriented firms be included in the assessment.

7.2 Conclusions

The world economy is becoming increasingly dependent on the knowledge-based goods and services - "smarter" more specialized products whose value resides mainly in the skill and ingenuity of the people who develop and manufacture them. Alberta must move away from its natural resources based economy if it hopes to maintain the current standard of living of its citizens as we move into the twenty-first century. This has been a main focus of government policy in recent years and the purpose of this study was to provide some information on what progress has been made

in terms of human resource capabilities, on what is expected to be needed in the future and on Alberta's ability to meet these needs.

The availability of a skilled labour force has been determined to be one of the key inputs into an advanced technology firm's locational decisions and Alberta has many of the necessary ingredients to provide such a labour force. However, the Alberta government and particularly Alberta Career Development and Employment must develop and implement a human resource strategy to ensure the required skills are developed and that mechanisms are in place to facilitate the matching of training supply to demand. Moreover, these initiatives must be coordinated with the other key actors in the delivery of education and training such as the educational institutions, the private training firms, other government departments and the advanced technology firms themselves.

Our study has shown that while no general labour shortage exists, specialized skills, particularly in biotechnology and telecommunications, are not available here in Alberta. As many firms are in the inception, prototype testing or early growth phases of development, there has not been overly large labour demand for the advanced technologies to date. However, this could change rapidly if a few firms achieved a threshold level of international sales and begin to grow rapidly. If such a situation does develop, the greatest demand will be for production workers and technicians. Demand for manager/entrepreneurs and scientists/engineers/researchers is expected to grow steadily in the next four years.

Several programs currently in place respond to some of the needs identified but more can be done. Some of the initiatives recommended in this report such as increased involvement of

industry in the educational process through cooperative and/or apprenticeship-like programs are supported by several industry sectors and could enhance the human resource capabilities in all firms, including those in the advanced technologies. Others such as the Training and Management Institute and a Technical Research Assistance Program can be targetted specifically to the advanced technology fields. Finally, a strategic procurement policy designed to strengthen local firms to the point where they can compete in the world market would strongly stimulate the development of a world class labour force to support the growth of advanced technology firms in Alberta.

APPENDIX A

TERMS OF REFERENCE

August 19, 1987

TERMS OF REFERENCE

A LABOUR MARKET ASSESSMENT

OF THE

HIGH TECHNOLOGY INDUSTRY IN ALBERTA

Alberta

CAREER DEVELOPMENT
AND EMPLOYMENT

Labour Market Information
and Planning Division

TERMS OF REFERENCE

1.0 INTRODUCTION

Science and new technology development are receiving increasing attention worldwide. Governments have realized that in order for the economy within their jurisdiction to remain competitive in the international market, strong technical and scientific capability must be fostered. Canada and the provinces are part of this new initiative as reflected in a 1985 decision by the Ministers Responsible for Science and Technology to establish a "National Policy on Science and Technology". A further commitment to science and technology in Canada is reflected in the creation of the National Advisory Board on Science and Technology that is chaired by the Prime Minister.

The new focus on science and technology is attributable to the impact it is having on the world economy and trade patterns. Technological developments are now becoming a major factor affecting the growth of economies. Governments, the private sector, and research institutions recognize that technological capabilities must be developed and implemented in order to maintain and improve economic competitiveness and productivity. As outlined in a background paper on the Canadian National Science and Technology policy:

> **"It is no longer possible to rely mainly on wealth generated from natural resources and the traditional manufacturing and service sectors. Rather, it is necessary to move to an economy based on the more intensive utilization of technologies to enhance the competitiveness of these sectors, as well as to create new knowledge-based industries."**

The major benefits of developing and implementing new technology are long-term and two-fold. First, the implementation of new technology to operations such as oil sands plants, service companies, and food processors will increase competitiveness. The second major benefit is the creation of new businesses that can export products and services of a high value-added nature.

The Alberta government recognizes the important benefits to the Provincial economy that can be derived from supporting the development and implementation of new technology. This commitment is reflected in the initiatives of various departments to facilitate the diversification and growth of the Provincial economy in areas such as:

telecommunications
medical products
biotechnology
electronics
computers and software
advanced materials (including plastics)
cold region engineering
advanced design, processing and
manufacturing

Specific examples of the Alberta Government's support in the above-mentioned areas include: establishing the Alberta Heritage Foundation for Medical Research; founding and jointly funding the Alberta Telecommunications Research Centre; establishing the Electronics Test Centre through the Alberta Research Council; and, providing financial support to establish the Alberta Laser Institute. In terms of expenditures, Alberta spent $222.2 million in 1984. This represented an expenditure on research and development that was three times more than any other province.

Other levels of government and organizations are also involved in developing a technology industry in Alberta. In Edmonton, the Advanced Technology Project -- a joint venture of the Edmonton Council for Advanced Technology and the Edmonton Economic Development Authority -- has been established to develop a plan to create a high technology centre in Edmonton. In addition, other organizations, such as the research and development park authorities in Edmonton and Calgary, are actively involved in further developing the technology industry.

Although other departments play lead roles in the economic development and diversification strategy, Career Development and Employment has an active and supportive role to play in developing a technology industry. Labour market supply is an important factor firms consider when

locating new operations. Labour market supply also affects the further expansion of technology firms that are currently in Alberta.

The availability of a skilled workforce is one of the most important factors that a high technology firm considers when locating in a region. In a major United States study of high technology firms, the need for a continuing supply of scientific and technical personnel was a consideration in nearly all plant locations. Furthermore, a supply of scientific and technical personnel was the single most important requirement for many companies. Studies undertaken in Alberta also support the U.S. findings. As a facilitator in developing and maintaining an appropriately skilled workforce, Alberta Career Development and Employment is proposing to undertake a study of current workforce supply and the skills required to meet the future growth needs of firms in Alberta.

2.0 STUDY DEFINITION: "HIGH TECHNOLOGY" AND "HIGH TECHNOLOGY FIRM"

The definitions of technology are as varied as the new technologies being developed. Common terms such as "high technology" and "leading-edge technology" are commonly used. However, as many authors point out, there is virtually no agreement on an exact definition. For the purpose of this study the term "high technology" will refer to those technology areas that are supported by the Alberta Government in the economic development strategy and the areas being promoted by other agencies such as municipal economic development groups. The areas include:

a) telecommunications;
b) medical products;
c) biotechnology;
d) electronics/microelectronics;
e) advanced materials including plastics;
f) computers and software;
g) cold region engineering
h) advanced design, processing, and manufacturing; and
i) energy

This study will incorporate a number of parameters to define a "high technology firm". The criteria used to define a firm has ranged from: the percentage of scientists and engineers on staff; the presence of short-term market shifts; and, research and development expenditures that

equal or exceed 3% of total profits or sales. In many cases, the research and development expenditure figure varies. Other studies have adopted Revenue Canada classifications.

A "High Technology Firm" in the proposed study will be defined as a private company, crown corporation or government agency that is in one of the aforementioned areas researching, developing, and/or manufacturing new technology or providing a related service.

3.0 PURPOSE

The purpose of the study is to:

a) prepare a labour market profile for Alberta, Edmonton, and Calgary using characteristics that are considered by high technology firms when evaluating the siting of an operation in Alberta;

b) document the programs available in Alberta's post-secondary institutions that supply the skills relevant to the high technology industry in Alberta;

c) determine the types of workforce skills that were recruited from outside Alberta by firms currently in Alberta and the reasons why out-of-province recruitment occurred;

d) determine the high technology growth areas in the next three years for firms currently in Alberta;

e) determine the skills not available in Alberta to meet current and future growth areas;

f) determine industry-based training requirements; and

g) propose a cost-efficient method of updating the information outlined (a to f), and an appropriate interval for updating the information.

4.0 SCOPE OF WORK

The consultant is instructed to prepare a report (Report #1). The first component of this report will:

1) Profile the Alberta, Edmonton, and Calgary labour market by using existing data sources to document labour force characteristics that are important to high technology firms considering an Alberta location.

   Labour force indicators that show Alberta or the major metropolitan centres in an advantageous position to other provinces would be highlighted by comparisons to those regions.

   The consultant must utilize labour force data available from the census, Labour Force Survey, and other relevant sources. This profile must include the following:

   a) a brief profile of the existing high technology industry in Alberta by areas such as biotechnology, medical and telecommunications; plus special facilities, including the Alberta Microelectronics Centre and the Alberta Research Council.

   b) population in 1981, 1986, and projected to 1991;

   c) the population growth rate from 1970 to 1986;

   d) historical population growth by major Canadian cities in 5-year intervals from 1961;

   e) the age distribution of the population in 1986;

   f) educational attainment of the population 15 years of age and older for 1986;

   g) employment by detailed occupation;

   h) employment by male/female distribution;

   i) wage rates by selected occupations;

j) labour market turnover by industry and occupation;

k) labour relations; and,

l) a description of Alberta Career Development and Employment and Federal training, business development and mobility programs, available to the high technology industry.

Report #1 should be presented in a format suitable for printing and public distribution to promote Alberta. It is envisaged that Report #1 will represent approximately 25% of the project.

2) The second component of Report #1 is an inventory of post-secondary programs available in Alberta institutions that can supply the high technology industry in Alberta. The inventory must be compiled for Alberta, Edmonton and Calgary. The inventory will include:

a) for each vocational-technical institution the number of graduates, teachers, and curricula for each program;

b) for each community college the number of graduates, teachers, and curricula for each program, plus a description of programs offered through continuing education;

c) for each university the number of graduates, teachers, and curricula for each program, plus a description of programs offered through continuing education;

d) for each private technical school the number of graduates, instructors and curricula for each program;

e) a description of each institution and the research undertaken including the monetary value and the links that the institution has with industry;

f) the placement rate of graduates by program plus wages; and

g) contacts for general information at each institution.

The consultant is instructed to prepare a second but separate stand-alone report (Report #2) that:

1) Documents the types of workforce skills that were recruited from outside Alberta by firms currently located in Alberta.

2) Documents the future growth areas for the next three years of high technology industry in Alberta and the skills required.

3) Documents the skills not available in Alberta to meet the current and future growth needs as identified in Point 2.

4) Identifies industry-based training requirements to meet the growth.

   The consultant will undertake components 1 to 4 by conducting approximately 150 in-depth personal interviews with the firm and agency contacts to be provided by Alberta Career Development and Employment.

5) Proposes a cost-efficient method of updating the labour market supply information in report #1 including an appropriate interval for updating.

5.0 REPORTING

The consultant will be required to submit the following reports:

a) two progress reports outlining the preliminary results of the personal interviews, and the compilation of information on general labour market characteristics and institutional programs;

b) draft final reports; and

c) the final reports including a separate executive summary of report #2.

The first progress report must be submitted by November 6, 1987.

The two draft final reports and executive summary must be submitted on February 1, 1988.

The two final reports and executive summary must be submitted by February 26, 1988.

Twenty copies of each progress report will be required.

Twenty copies of each draft final report and executive summary will be required.

Twenty copies of the final reports #1 and #2 and executive summary will be required.

6.0 TERMS AND CONDITIONS

The Department of Career Development and Employment reserves the right to

1) Reject any or all of the Requests for Proposals.

2) Retain the submissions made in response to this request.

7.0 PROPOSAL SUBMISSION DEADLINE AND STUDY TIMING

Proposals must be submitted by 2:00 p.m. on Wednesday, September 9, 1987.

The final selection of the consultant will be made by Friday, September 18, 1987.

Data collection and analysis should commence on Monday, October 5, 1987.

8.0 MEETING ATTENDANCE BY CONSULTANT

The consultant may be required to attend up to three meetings to present the progress reports and final report.

9.0 SPECIAL CONTRACTUAL CONDITIONS

Survey forms and data from the survey must remain confidential and the exclusive property of Alberta Career Development and Employment.

APPENDIX B

INTERVIEW GUIDE AND INTERVIEWER INSTRUCTIONS

ALBERTA ADVANCED TECHNOLOGY MANPOWER SURVEY

INTERVIEW GUIDE

Interviewer ________

Date ______________

January 13, 1988

1. NAME OF FIRM ____________________ 2. TELEPHONE ____________________

3. ADDRESS ____________________ 4. CITY/TOWN ____________________

____________________ 5. POSTAL CODE ____________________

6. CONTACT PERSON ____________________ 7. POSITION ____________________

COMPANY PROFILE

8. In what year did the firm begin operations? ________ in Alberta? __________

9. INDUSTRY (i.e. Electronics, Computers) ____________________

10. In what fields does the company specialize? (i.e. Microprocessors, Software Design)

a. ____________________ b. ____________________

c. ____________________ d. ____________________

11. What are your firm's principal products (P) or services (S)? (List in order of sales revenue)

Are the products manufactured here in Alberta? (Indicate with an "M")

a. ____________________ b. ____________________

c. ____________________ d. ____________________

12. In what areas are you undertaking (or considering for the future) research and development here in Alberta?

a. ____________________ b. ____________________

c. ____________________ d. ____________________

13. What do you see as particular strengths of the company (competitive advantages)?

____

____

14. At what stage of development is the company? (ie Where is it in terms of its product life cycle?)

______Inception _______Prototype testing ______Growth (1st product) ______Mature (several viable products

15. Please indicate the range of your Alberta-based corporate sales (shipments or services from Alberta) for the last fiscal year. (We need to estimate the wealth generating effect of high technology firms.)

_____ $0-50,000 _____ $51,000-100,000 _____ $101,000-500,000 _____ $501,000-1 Million (M)

_____ $1.1 M - 5 M _____ $5.1 M-10 M _____ $10.1 M - 50 M _____ $50.1 M - 100 M _____ $100.1 M +

LOCATIONAL CHOICE FACTORS

16 a. Prior to the establishment of this particular firm in Alberta, did the key decision-makers reside in Alberta? Y___ N___

b. If yes, did the decision-makers consider locating elsewhere? Y___ N___

What kept the firm here in Alberta? ______________________________

c. If no, where were they located? ______________________________

17. (All firms) What were the key factors considered when evaluating the siting of the operation in Alberta? Please rank on a scale of 1 to 10 with 1 being the most important. (Multiple choices of the same rank allowed.)

____ Accessibility to investors or venture capital groups

____ Ability to expand

____ Quality of life factors for employees, including affordable housing, low real estate taxes and wide range of cultural, recreational and educational opportunities (underline key factors)

____ Familiarity with area by decision-makers

____ Availability of shared support services (incubators)

____ Favorable tax levels and availability of tax incentives

____ Low-cost strong potential workforce in region with minimal labour problems

____ Image area or address

____ Affordable land, rent, and building costs for plant

____ Ample supply of qualified scientific and management staff

____ Proximity to quality university that can offer faculty, student and equipment support

____ Proximity to supplier and customer markets

____ Supportive community that encourages entrepreneurship

____ Proximity to government research labs

____ An efficient transportation network that provides easy access to potential site.

____ Established networking with nearby universities

____ Proximity to company's headquarters or ability to consolidate operations

____ Other ______________________________

EMPLOYMENT AND HUMAN RESOURCE CAPABILITIES

18. Please estimate, to the best of your ability, the number of employees your firm had or expects to have in the following categories on January 1 for the following years.

	1984	1986	1988	1990	1992	Key Factor
	(Actual)			(Estimated)		
Managers, Entrepreneurs	___	___	___	___	___	___
Scientists, Engineers, Researchers	___	___	___	___	___	___
Technicians (Research)	___	___	___	___	___	___
Production personnel	___	___	___	___	___	___
Marketing Personnel	___	___	___	___	___	___
Administrative Support Staff	___	___	___	___	___	___
Other ________________	___	___	___	___	___	___
________________	___	___	___	___	___	___

19. In the right hand column of the question above, please indicate for each group, whether academic training (A) or field experience (F) is more important.

20. Qualifications:

a. ACADEMIC: Please indicate the number of people with the following qualifactions for each category.

	Dipl.	Bach.	Masters	Ph.D.
Managers, Entrepreneurs	___	___	___	___
Scientists, Engineers, Researchers	___	___	___	___
Technicians	___	___	___	___
Marketing Personnel	___	___	___	___

b. How many YEARS OF EXPERIENCE do you require for new hires in each category?

Managers, Entrepreneurs	___
Scientists, Engineers, Researchers	___
Technicans (Research)	___
Marketing Personnel	___

c. What do you consider as necessary relevant experience for new hires in the following categories?

Managers, Entrepreneurs ____________________

Scientists Engineers ____________________

Technicians (Research) ____________________

____

21. Recruiting

a. How many of your current staff (in each category) did you recruit from:

	Within Alberta	Elsewhere in Canada	Outside Canada	Total
Managers, Entrepreneurs	____	____	____	____
Scientist, Engineers	____	____	____	____
Technicians (Research)	____	____	____	____
Production Personnel	____	____	____	____
Marketing Personnel	____	____	____	____

b. When you recruited from within Alberta, did you recruit on a broader geographic area? Y___ N___

c. When you recruited from outside Alberta, did you attempt to hire within the province? Y___ N___

d. For what particular workforce skills did you have to go outside the province?

____

____

____

FUTURE DIRECTIONS

22. What are the advanced technology growth areas in your industry over the next three years?

____

____

23. What will the critical manpower requirements (high demand skills/occupations) be over the next three years in the following employment groups. (Please be specific and relate to the employment forecasts made in Question 19 above.)

Management ____________________

____

Scientists, Engineers ______________________________

____

Technicans (Research) ______________________________

____

Production Personnel ______________________________

____

Marketing Personnel ______________________________

____

24. What retraining or upgrading needs do you have? ______________________________

____

____

EDUCATION AND TRAINING PROGRAMS

25 a. What university programs are particularly useful to you in terms of generating qualified graduates and what characteristics make them so valuable? (Please be as specific as possible in defining the programs.)

____

____

____

b. Technical institute programs?

____

____

____

c. Community college programs?

____

____

____

26. How could these programs be improved? (More hands-on experience, more marketing skills etc)

(Also relate these comments to the specific programs as much as possible.)

____

____

____

27. What programs outside Alberta do you utilize or have considered using? ______________________

____

____

28. What new programs need to be developed in Alberta? ______________________

____

____

NOTE: In many previous manpower studies, industry representatives have often recommended more co-operative programs or more industry-based training as approaches to improve the capabilities and effectiveness of Alberta's labour force. However, rarely do the studies go any further than these broad recommendations. We would like to explore these issues in a bit more depth here. (This exploration does not imply that the government will introduce programs of this nature but it is interested in understanding more about how such programs might be best implemented.)

29 a. Has the company been involved in any cooperative programs with the institutions? Y___ N___

b. If yes, how successful was the venture? ______________________

____

____

c. Would your firm be interested in becoming involved in some sort of co-operative program with one of the institutions Y ___ N ___

d. If yes, are there any specific requirements you would want to impose? (Timing, number of students, control of work activities, etc) ______________________

____

30 a. In what areas do you think industry-based training would be effective? ______________________

____

____

b. Who should provide this training? ______________________

c. How long should this training be? (2 days? 1 week?) ______________________

d. When should this training be offered? (Evenings? Weekends?) ______________________

e. How can quality control be maintained? ______________________

____

ALBERTA ADVANCED TECHNOLOGY MANPOWER SURVEY

LOCATIONAL CHOICE FACTORS:

(All firms) What were the key factors considered when evaluating the siting of the operation in Alberta? Please rank on a scale of 1 to 10 with 1 being the most important. (Multiple choices of the same rank allowed).

----- Accessibility to investors or venture capital groups.

----- Ability to expand.

----- Quality of life factors for employees, including affordable housing, low real estate taxes and wide range of cultural, recreational and educational opportunities.

----- Familiarity with area by decision makers.

----- Availability of shared support services (incubators).

----- Favourable tax levels and availability of tax incentives.

----- Low-cost strong potential work force in region with minimal labour problems.

----- Image area or address.

----- Affordable land, rent and building costs for plant.

----- Ample supply of qualified scientific and management staff.

----- Proximity to quality university that can offer faculty, student and equipment support.

----- Proximity to supplier and consumer markets.

----- Supportive community that encourages extrepreneurship.

----- Proximity to government research labs.

----- Efficient transportation network that provides easy access to potential site.

----- Established networking with nearby universities.

----- Proximity to company's headquarters or ability to consolidate operations.

----- Other ____

____

____

ALBERTA ADVANCED TECHNOLOGY MANPOWER SURVEY

INTERVIEWER INSTRUCTIIONS

January 13, 1988

PURPOSE

The purpose of this survey is to better understand the current and future manpower needs of the advanced technology firms in Alberta and the extent to which these needs can be met with Alberta resources. A secondary purpose of this study is to develop a marketing document on Alberta's manpower resouces for high-tech firms that are considering locating in this province. (I use the terms advanced and high technology reasonably interchangeable with a slight preference for the former - don't get caught up on definitional semantics on this.)

For this survey, advanced technology is defined as firms in the fields of:

biotechnology; electronics; computers and software; advanced materials (i.e. photonics, chemicals); medical products; telecommunications; advanced design, processing and manufacturing; and cold region engineering.

Energy as a field has not been included so as to focus on the smaller, more embryonic firms and industries that are more likely to benefit from new government programs or policies than the Shell's, Syncrude's and Esso's of the oil and gas field.

INTENDED USE OF THE STUDY RESULTS

The advanced technology field has been defined as a key priority of the Alberta government and the government has devoted an impressive amount of resources to the development of these industries in the province. Note for example, the Alberta Microelectronics Centre, the Alberta Heritage Foundation for Medical Research, the Electronics Test Centre and perhaps most importantly, the Alberta Research Council. Moreover, the government just announced in Dec/87 approximately $10 million dollars for a facility to house the Centre for Frontier Engineering Research. Our study represents part of these ongoing efforts to support and encourage the development of advanced technology industries in Alberta and explores an area that has not been comprehensively studied in the past. The results will be presented to a senior committee of deputy ministers involved in supporting these industries.

CLIENT

We are doing this study on behalf of Alberta Career Development and Employment. Anyone with questions can contact Dr. Bev MacKeen or Jim Klingle of the Labour Market Information and Planning Division at 427-8501.

TARGET INTERVIEWEES

The ideal person to talk to in each firm would be the senior person responsible defining future manpower requirements and current

manpower capabilities. In many cases, one person will handle both responsibilities but in the larger firms, the Vice-President of Personnel may be the best person to provide the data on the numbers, experience and credentials of the current workforce while the V-P for R and D may be the one to define future growth areas and the required skills.

SAMPLE OF FIRMS TO BE INTERVIEWED

A sample of approximately 150 firms has been drawn from Alberta Technology, Research and Telecommunications' CANTECH data base. While the categories within the database do not exactly correspond to the eight research fields defined above, a comparable set of industry groups was defined and all firms in these groups were identified. Then a representative sample has been developed. All firms in the smaller fields such as biotechnology have been included in the sample of 150 firms while approximately one in four was drawn from the largest industry group, computer software. the firms selected were representative in terms of location and size of all firms in each particular industry group.

The Electronics Industry Association of Alberta (EIAA) recently completed a complex survey of its members and so we have decided to use the results from this survey rather than duplicate the data collection process. Therefore, with five exceptions. firms that completed the EIAA survey are not been asked to contribute to this High Tech survey. The five exceptions are Bow Valley Resources, LSI Logic, Myrias Resources, (all three are on the High Tech Study Advisory Committee and will be asked to be part of the focus groups), Keyword Technologies and Novatel Communications. If any other EIAA firms are encountered in our survey, thank them for their time and note that their industry will be covered through the previous survey.

NUMBER OF INTERVIEWS TO BE COMPLETED

Our target sample size is 80 industry interviews. These must be representative of the overall sample drawn in terms of research field, location and size. We will also identify several "stars" that will be must interviews within the set of 80. Examples here are the five companies identified above.

It is critical that we complete these by Feb 7 and get the write-ups to Calgary by Feb 10/88. Any later and the whole study will be delayed by the Olympics.

We will also be intrviewing key academic and government representatives. (Richard Roberts will do several of these.)

INTERVIEW PROCESS

All interviews are to be in person, except for the out-of-town firms which can be done by telephone. This latter group should be mailed the interview guide so that they have something to refer to in the interview. It is expected that the interviews should take an hour so that you should be able to complete four interviews per

day. Anyone interviewing in Edmonton must make a point of meeting with Bev MacKeen and Jim Klingle. This is a very simple way of keeping them informed about the study.

QUOTABLE QUOTES AND SUCCESS STORIES

A key part of this study will be the development of a marketing document for international distribution on Alberta's human resource capabilities in the advanced technology areas. As such be alert for 'Quotable Quotes' or interesting success stories that can be used in the marketing document. We are more interested in the people's successes rather than the company's - how did they get the idea for the product; how did they get started; did they receive government help and was it effective; did they find their key people in Alberta and, if so how; and if they had to recruit out of province, why did the employees want to come to Alberta.

If you find a company or person particularly interesting, find out whether they are interested in being quoted in the marketing document, make notes as to why they are potential candidates and let them know that Richard Roberts or one of his PRAXIS staff may be contacting them for more information. Let us know who these candidates are as quickly as possible. (Richard's telephone number is 403-245-6404.)

Also be on the lookout for interesting photographs or photo subjects that might be used in the document. Again discuss the possible inclusion in the marketing document with the client. It may be possible to do a special photo shoot for this study, therefore try to identify interesting opportunities that will illustrate the people component to the research or manufacturing process.

SUBSEQUENT PHASES

The data will be analysed and policy suggestions/recommendations developed. Then a series of focus groups by industry will be convened to test the validity of the analysis and finetune (or redraft) the conclusions and recommendations. Let us know if anyone is particularly interested in participating in one of these focus groups.

EXPECTED COMPLETION DATES

We are shooting to get the final report to the client by April 30, 1988 so the results of the study should be publically available by June or early summer.

THE INTERVIEW GUIDE

1. You will already have information for Questions 1-7; please confirm that it is correct.

2. Q8. Age of the firm, together with growth rates, and stage of development will allow us relate manpower information to key

structural characteristics and thereby imporve our ability to forecast manpower requirements.

3. Q9. We are looking for one of the eight industries defined above under PURPOSE but some respondents may prefer 'energy', 'agriculture', or 'seismic' for example.

4. Q10. Please be as specific as you can here as this will allow us to see how finely the participants in an industry partition their markets.

5. Q11. It will be important to understand whether the firms are more product or service oriented and where the largest markets within an industry are. If you can, determine if one product or service is dominant.

6. Q12. Again be as specific as you can here as this information will be related to the manpower requirements defined later in the interview.

7. Q13 will allow us to identify whether Alberta high tech companies consistently identify the same competitive advantages.

8. Q14 links back to Q8 and might allow us to relate the manpower needs with observable characteristics.

9. Q15 on the revenues of the firm is very important to the overall study but is the one respondents may be most hesitant to answer. Several research articles have stressed that the high tech industries have more of a wealth generating effect on the economy than an employment generating effect and this question will help us evaluate that conclusion. It aso has important implications for support strategies.

10. Q17 on locational choice factors is also key to the study but to properly interpret Q17, information is needed on how the initial location-siting decision was made. This will be given by Q16. If the respondent begins to identify several locales for the decision-makers prior to Alberta, try to isolate where the KEY decision-maker came from.

11. Q17. The respondent has to rank several locational factors in this question so a special hand-out page has been prepared where this question is replicated. Please give this hand-out to your interviewee at this time.

12. Q18 on historical and projected employment is the most important quantitative question in the interview. The smaller firms should have no problems with this question but it might be useful to alert respondents for the medium-sized or larger firms of the data required here during the initial telephone contact.

13. NOTE The most frequent criticism by industry people of government-sponsored studies such as this is that the results are not detailed enough to be of use to them. In the next twelve questions, we try to develop some of the specificity they require.

14. Q20 examines the question of qualifications. The respondent may not know the exact numbers here but ask him or her to estimate these splits as closely as possible. Q19 will give us a sense of the relative importance of Q20a and Q20b. The third part of Q20 is deliberately open-ended and may provoke answers such as " 5 years of actual field experience with supervisory responsibilties - just academic experience just won't do!" or "We only hire graduate students who have worked with us on our joint research with the Alberta Research Council".

15. Q21 explores the question of recruiting practice. Understanding this process is absolutely fundamental to academic institutions and government agencies if successful manpower supply strategies are to be implemented. We are looking to identify the wheres and whys of recruiting in this question. "Broader geographic area" means "in other locales such as Toronto, Vancouver or Houston".

16. Q18 - Q21 are meant to understand current and historicial employment levels by broad occupational group, qualifications of current staff and prior recruiting strategies.

17. The next two questions (Q22-Q23) have a future orientation and are intended to add some qualitiative dimensions to the employment projections provided in Q18. Again you will have to be as specific as you can!

18. Recommendations on previous manpower studies have included such items as "more computer training", "teach more business communicaiton skills in university programs", develop more co-op or intership programs". Again the criticism is that they are too general to be very useful. In Q24 - Q30, we explore why some programs are particularly useful to industry, how co-operative programs might be implemented or how training programs might best be structured. They should also help convert general criticisms of the government and academic institutions into something more constructive.

19. Examples of industry-based training in Q30 might be marketing courses put on by the industry association or proposal design workshops for microelectronics firms.

20. Q32 is a final opened question so that the respondent can address specific concerns or irritants that he or she feels strongly about.

RANDOM NOTES

1. Some people have suggested that the U of A graduates in Artifical Intelligence must go out of province for jobs because there is no market here in Alberta. Test this opinion if you are interviewing someone in this field of research.

2. Highlight any firms you can identify that are spinoffs from the universities. This is very useful information.

3. Watch for examples of "underemployment" - that is a lack of full utilization of skills. Again this is a comment made in some of the literature.

CONCLUDING REMARKS

We will have covered a number of different topics quickly in the course of the interview and so it is very important that each Interviewer understands very clearly the purpose of each question and the overall survey. Review the interview quide and these notes carefully because I will be out of the country when much of the interviewing must be done.

Norm

Norm Carruthers
Project Manager

APPENDIX C

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BIBLIOGRAPHY

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